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SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

April, 1944
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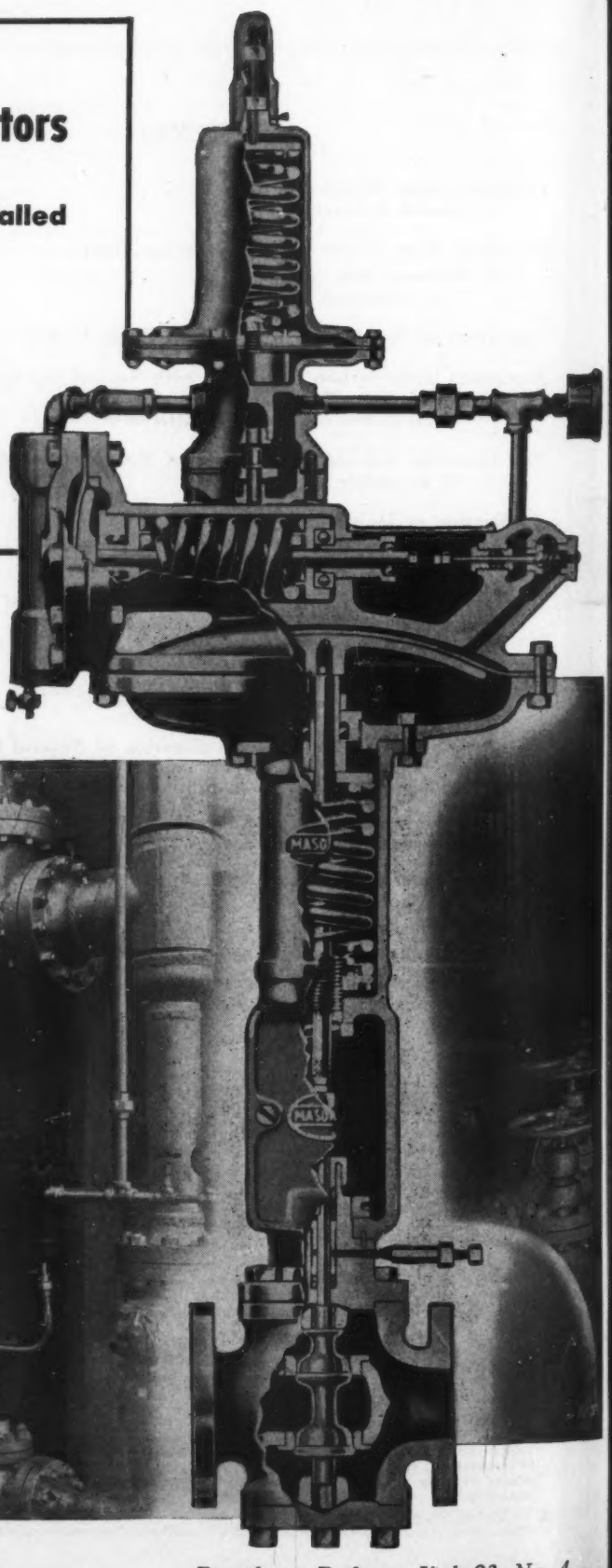

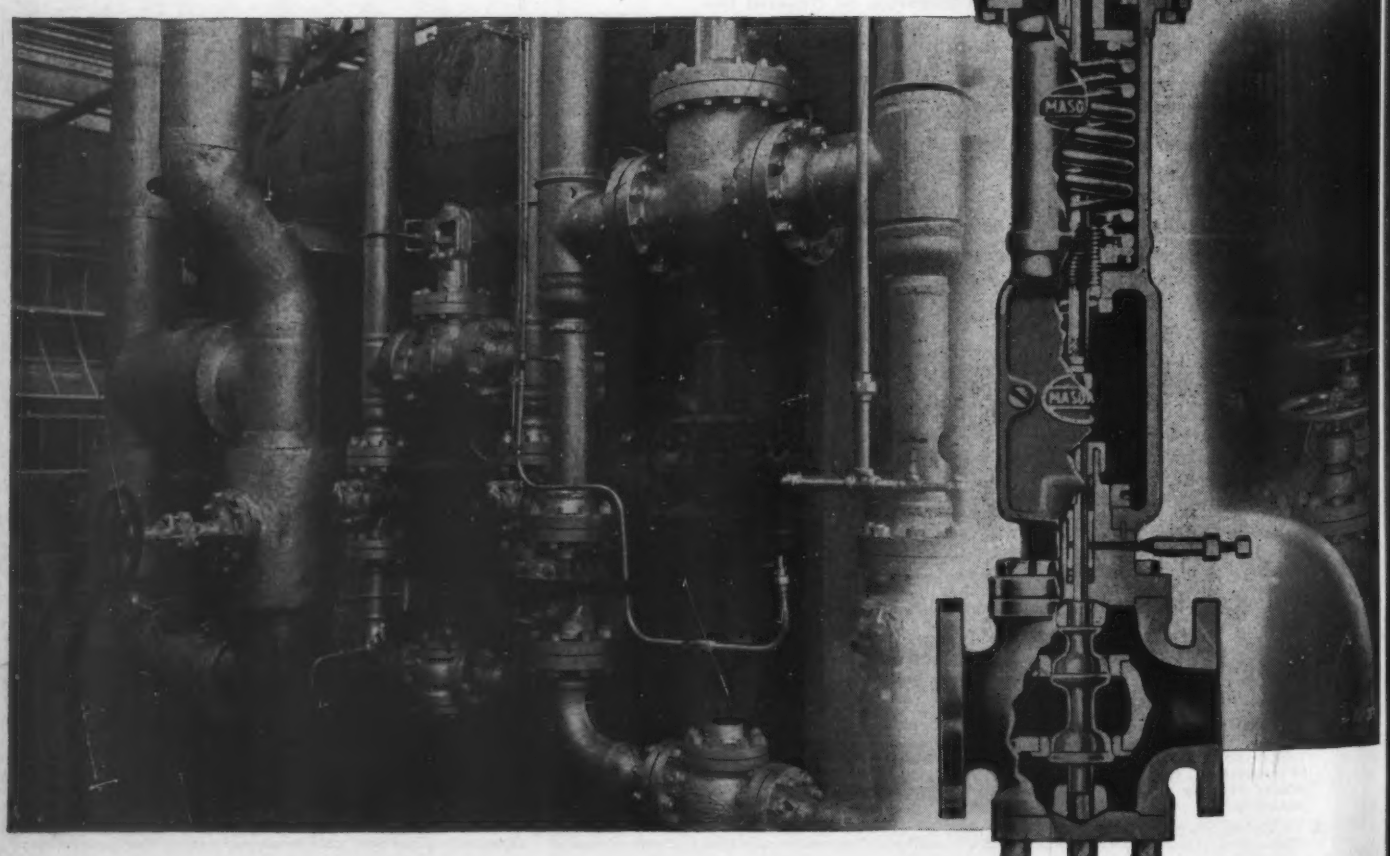

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THE LOOK BOX

Sweet Music

NOW that the plant-construction program is 75 percent complete and there is assurance that the military will have 100-octane aviation gasoline in sufficient quantity and quality, it is certain that one agency of government, the Petroleum Administration for War, will reduce its personnel and seek a lower appropriation for the next fiscal year—

But the facts are otherwise. Instead the budget sought for PAW proposes an increase of $480,000, part of which will be spent in paying the salaries of 107 additional employees. For the Division of Refining 65 additional employees are sought, 42 in domestic refining activities and 23 for the carrying of plant building and plant supervision into foreign lands.

Only yesterday this writer chanced to pass a street corner where some musicians had set up their equipment in order to bear down in modern jive, eight-to-the-bar with little regard to harmony as it was understood in the gay nineties. While the bull fiddler coaxed an approach to tempo from the cat gut, his eyes roamed restlessly into the crowd with that peculiar expression which admits existence of the multitude although its individuals are not personally known to the artist. The clarionet player had his eyes closed while his deft fingers wandered up and down the licorice stick, which seemed to protest but still had to give up the sounds that were demanded in the name of music. They were all there, the trumpet, the tuba, the drums and the accordion or squeeze box.

Now there is nothing novel in men getting together for a session of swing music. They are paid for it according to scale. Still, there is something unusual when the male members of a honky-tonk orchestra get out of bed well before noon in order to offer their services toward inducing girls to join the WAC. That was what the noise was all about. Men were doing their best to swell the ranks of the female division of the fighting forces of the United States Army.

It seemed that the pinnacle of inconsistency had been reached.

Such, however, was not true. Within an hour this part of the justification for the added money and the enlarged personnel of the Division of Refining of the Petroleum Administration for War came to attention:

"Together with the lack of industry experience in dealing with the virtually unknown operating variables of new manufacturing processes, demands for overall control the central pooling of the best technical staff that can be obtained from the industry and the maintenance in the field of a group of engineers available for advice and instruction at the many plants that will be producing high-octane constituents."

Such is a part of the stated reason for more men and more money in the refining division of PAW. It is a classic in contradiction. Only by going to the industry can it get a staff capable of advising an industry which is not familiar with its processes. As for lack of experience, it was only a few weeks back that a press release from PAW paid high tribute to the industry for its ingenuity (another word for experience) and its resourcefulness.

At that time Harold L. Ickes, administrator, said that 65 percent of the output of 100-octane fuel in the first two years after Pearl Harbor was figuratively "wrung out of a hat." Now an increased budget is being sought because the same industry is lacking in experience.

The presumption is that Administrator Ickes read both his press release and the increased budget. That, however, is mere assumption, for PAW's public relations division now consists of 13 men and the proposal is to increase it to 23, so an expenditure of $42,000 can be accomplished in the next year, as against $35,000 last year. Even 13 men can turn out so much copy that it would be difficult for any administrator to be sure of his words. With a larger staff and more money, the confusion will become more confusing.

Frequently Administrator Ickes has said that he favors the dissolution of PAW after the war. No one can read the budget proposal and the reasons given for the larger staff and increased expediture without doubting these statements. If this agency becomes established as these arguments propose, the petroleum industry can accept permanent supervision, with even its research and its operating methods dictated from Washington and its methods checked frequently by bands of roving technicians.

It seems like a good time to write to a Congressman.

SURRENDER to the big plant is so easily accepted that it is seldom deemed fitting to learn facts. Within the past two years the aviation-gasoline program has been surrendered to the big companies and the big plants.

Small Scale

But there are 76 refining companies which are providing aviation-grade gasolines of octane rating lower than 100 or simply furnishing one or more of the ingredients for making aviation gasoline. Within this group 48 names are of small corporations and represent small plants.

Evidently aviation-grade motor fuels are like other finished products, the size of the plant is not so important as the quality of merchandise.

WHEN 41,500 persons lose their lives in the accidents of a year (1943) first reaction is that industry should find more effective means of educating its employees. But more than half (23,500) of these deaths were from accidents off-the-job. Roy S. Bonsib, safety director for Standard Oil Company (New Jersey), cited the contrast in his appearance before the Greater New York Safety Convention, March 30.

When Off The Job

He classed the trend as a challenge to industry and offered two programs for influencing the safety of the worker when off-the-job. He admitted that the approach is difficult, for:

"The problem of preventing off-the-job accidents is a particularly difficult one with which to deal because it involves the private life of the worker. You can tell a man what he must do for his own good in a plant but when you start telling him what to do off the job you may incur resentment and resistance."

But the accident in the home has its effect in the plant as he pointed out:

"In terms of time lost to our war production, home accidents in one year had the effect of shutting down 60 factories, each employing 1000 workers for one year."

ALTHOUGH some production of butadiene is coming from conversion of used equipment to its processing, it was evident several months back that this part of the synthetic-rubber program was more appealing than practical. Colonel Bradley Dewey, Rubber Director, has observed that it is the better policy to provide equipment for a process than to attempt to shape a process to fit equipment.

The New Is Best

In several instances the conversion jobs were accomplished when one engineering staff confined its equipment search to its own yard or its own company and these have been successful. When organizations were set up in large measure for the purpose of combing the country for junk, the result was an accumulation of junk.

There can be no dictum to the effect that a piece of equipment can not be moved and used, still the experience of the past two years has been such that fabricators of new equipment have won a higher rating. New vessels and new machinery are cheaper as well as more satisfactory.

MOST appealing of the suggestions for stimulating industry once the guns cease firing is the simple goal of producing low-cost merchandise. Fortunately this country has experience of that sort and it will serve its purpose in world trade as it has in domestic trade.

Low Cost

Nothing could rate higher favor with the peoples of the world than the opportunity of buying essentials at low cost. Goods are not to be confused with spiritual programs. But it is evident that discord in politics comes when people have insufficient goods. In that surrounding the dictator finds fertile soil for false ideas.

It is to be hoped that the makers of the peace recognize the desirability of permitting goods to flow from one country to another at low cost. Then industry can thrive and serve mankind as well.

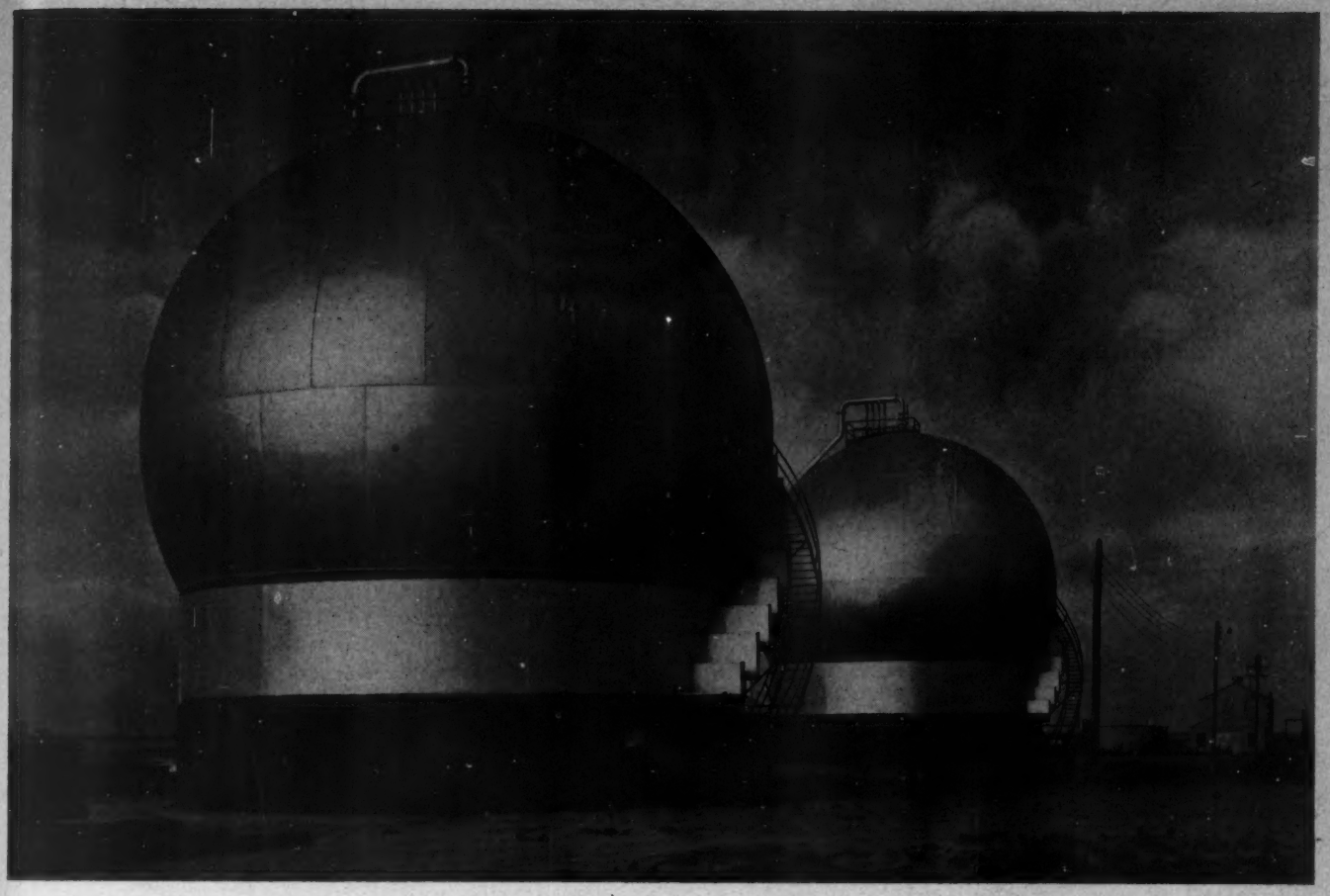


Photo Courtesy Wyatt Metal & Boiler Works

Pumping Light Hydrocarbons

How the Problem Has Been Solved in Spite of Added Complications

REUBEN G. LOVELL, Development Engineer
Hancock Oil Company of California

THERE was a time, not too long ago, when the only type of pump considered suitable for handling natural gasoline, for example, was of positive displacement, either duplex or simplex. At that time steam was not thought of as a scarce implement, since gas for boiler fuel cost practically nothing. As time went on, however, the manifest advantages of centrifugal pumps created a demand that they be used where practicable. The first of these pumps supplied were of a design which had been satisfactory for pumping water at elevated temperatures and it was felt that they should be suitable for handling light gasolines. The manufacturers were wisely careful, however, to specify to the purchaser that he must provide flooded suction, else the pump could not be expected to operate satisfactorily. The operator could not, in many cases, see why he must provide any different set of conditions outside the pump than had been his custom with steam pumps. This, of course, brought on endless argument, with the centrifugal pump frequently being left with a black eye. After some further time, refinery and natural-gasoline-plant men came to realize that if they hoped to avail themselves of the all-around utility of the centrifugal pump for handling light fractions, they must provide such suction conditions as would insure a pressure at the suction flange of the pump which would be at least equal to the vapor pressure of the gasoline at the pumping temperature. In fact, a pressure several pounds above vapor pressure was found to be good insurance against trouble from vapor binding in the pump itself.

Stabilizing Presents New Angles

When the practice of stabilizing the natural gasoline began to be popular, a new difficulty arose. To

FIGURE 1
Minimum-clearance simplex pumps.

provide reflux for the stabilizing column it was necessary to pump the lightest fraction to be recovered. This reflux was usually a combination of the butanes with some propane present. The column pressure ran all the way from 30 to 200 pounds per square inch, or more, which seemed ample for the pump suction, in fact was an incentive to carelessness in designing and installing the piping to the pump section. Trouble started all over again but did not persist simply because the pump designers at once realized that they must so design the entrance ducts within the pump, particularly the impeller eyes, that local turbulence and consequently localized vapor pockets could not exist. Tendency toward higher pump-shaft speeds complicated the design, but the difficulties were overcome and a new two-bit word—cavitation—came into general use and understanding. We who operate pumps need not concern ourselves with any except one of the phenomena of cavitation *inside the pump*. We must keep in mind, however, that cavitation with its attendant troubles can and frequently does exist in a suction line to a pump, and, until we have learned to avoid the piping errors which cause it, we cannot "pin the britches" on the pump manufacturer for unsatisfactory centrifugal-pump operation. In general, the rule is to provide such suction pipe area that the total head loss from the point at which suction is taken, to the pump, will leave a liberal positive head at the suction flange. This often dictates a pipe size larger than the suction flange, in which case it is vital that the change in size be accomplished by an eccentric reducer. This is very important because, if done with the conventional bushing or concentric reducer, such bubbling as may have been caused thereby does not have time to return to liquid phase before entering the impeller eyes where the liquid is necessarily subjected to further turbulence and head loss. The one point about cavitation within the pump which will be of interest to operators is an active corrosion or pitting of the metal in the pump which cannot be accounted for altogether by the corrosive nature of the liquid being handled. It has been most often observed with small, high-speed pumps operating against considerable heads. The cause has been traced to the collapsing, by the velocity head, of the minute vapor bubbles of cavitation. A slight change in interior pump design seems to have overcome the difficulty.

Steam Pumps for Light Fractions

The well-known tendency of the duplex pump to short-stroke removes it from consideration for handling very volatile petroleum fractions. Up to a point, the simplex pump of conventional design has been satisfactory for handling gasoline. The valve motion of a simplex is so arranged that each stroke is completed, or, in other words, it does not short-stroke, but it still is inefficient for the duty under discussion because of clearance volume and other details, which can be the cause of gas binding and other troubles.

There is another type of simplex pump, called the close-clearance type, the design of which is carried out somewhat on dry vacuum pump or gas compressor lines. This pump operates very satisfactorily in pumping very light hydrocarbons and is suitable for use in many conditions which can tolerate the rather minor disadvantages of a slow-moving, reciprocating unit and the steam consumption involved.

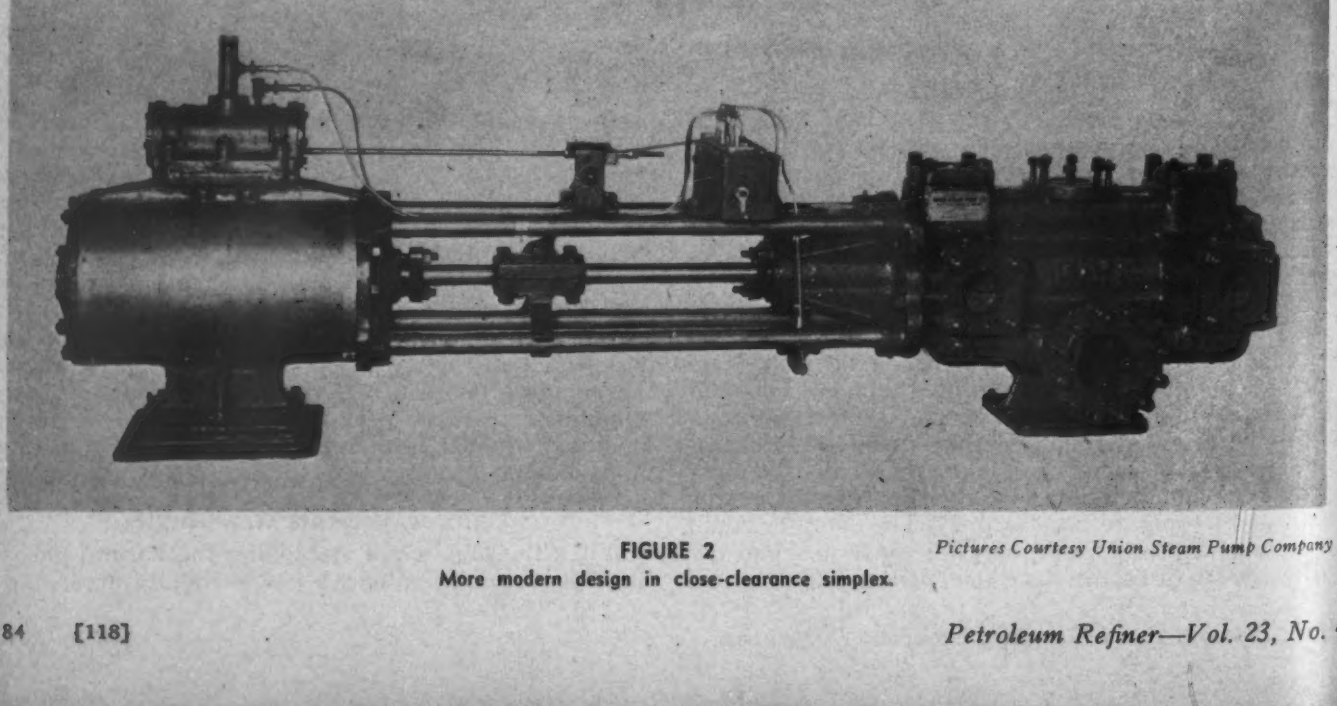


FIGURE 2
More modern design in close-clearance simplex.

Pictures Courtesy Union Steam Pump Company

It should be noted that the simplex pump, particularly this type, is easier on steam than a duplex.

The Modern Design Close-Clearance Simplex

Several things had to be learned before the bugs were all chased out of the simplex close-clearance pump for light hydrocarbons. The writer believes it pertinent here to remark that one of the convictions which he has as a result of some 40 years of experience is that, in order to solve an engineering problem satisfactorily, one must do it wrong some number of times and should not, therefore, take these on-the-way errors too seriously. Just be sure to learn something from each of them, enough to pay the cost of the error.

The pump manufacturers attempted, at first, to utilize their existing liquid-cylinder patterns which were principally designed for handling hot oil, since it was felt that the problems were similar. This was an improvement over the cold-oil pump because the liquid cylinders were better designed, the passageways were shorter and the stuffing boxes were deeper. The gasketing was improved by using rings and grooves. The cover plates were much heavier, the bolting was heavier, so altogether this design was a decided improvement over the old valve-plate or deck-type pattern.

When we started processing for butane and even lighter fractions, it became apparent that still more improvement was needed. Models were developed which retained all of the desirable features of the so-called side-pot pattern pump, with a number of more advanced features, the principal one being the increase in ratio of the length of the stroke to the diameter of the cylinder. A lantern gland for conducting lubricant to the packing in a very much deeper stuffing box and, better packing materials, eliminated troubles which arose from lack of lubricating properties of these light fractions, and reduced scoring and excessive wear on the rod.

Valve and Piston Improvement

Light-weight valves were designed and utilized. For a time considerable difficulty was experienced with the piston rings but this was eliminated through the use of graphitized micarta and other similar materials and by placing each ring in a separate groove. It has further been found that bringing liners to a high polish, perfect dimension and rotundity by honing has more than paid its cost. Use of a tail rod is advantageous in maintaining the accuracy of piston and liner fit.

Figure 1 illustrates some of the features referred to. These pumps are handling reflux in a stabilizer unit which is used on both cracked and straight-run stocks.

Figure 2 brings out clearly the extraordinarily deep stuffing box which is used in some of the advanced types. This pump is used in an isomerization plant, handling a mixture of hydrochloric acid and light hydrocarbons. Particularly should be observed the provisions which have been made to insure adequate lubrication to the lantern gland in the stuffing box, by providing leads from the forced-feed lubricator. This should take the thoughts of the old-timers back 30 or more years, when it was the custom to use a light, sheet metal cage surrounding the rod and secured by the gland bolting. The cage was filled with waste and some oil was added if and when the operator remembered to do so. Such of this oil as managed to cling to the rod on the out stroke was promptly wiped off again by the outside ring of rod packing on the return stroke.

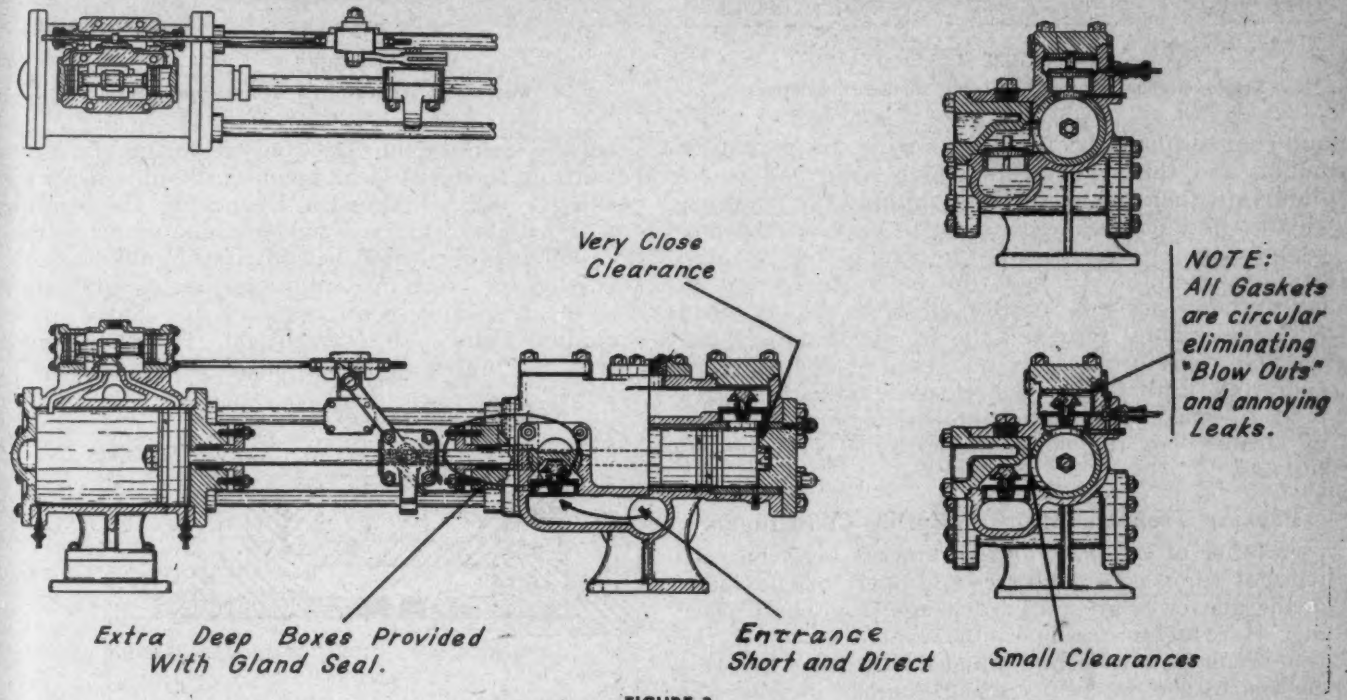

Very Close Clearance
NOTE: All Gaskets are circular eliminating "Blow Outs" and annoying Leaks.
Extra Deep Boxes Provided With Gland Seal.
Entrance Short and Direct
Small Clearances

FIGURE 3
Sectional view of close-clearance pump.

Courtesy Union Steam Pump Company

Figure 3 is a sectional view of a close-clearance simplex pump of popular make. Study of this view will do more to clarify the points to be emphasized than any number of words.

Altogether, the modern minimum-clearance, simplex pump has proved very satisfactory for handling light hydrocarbons in both the natural-gasoline plant and in the refinery. They have the inherent simplicity

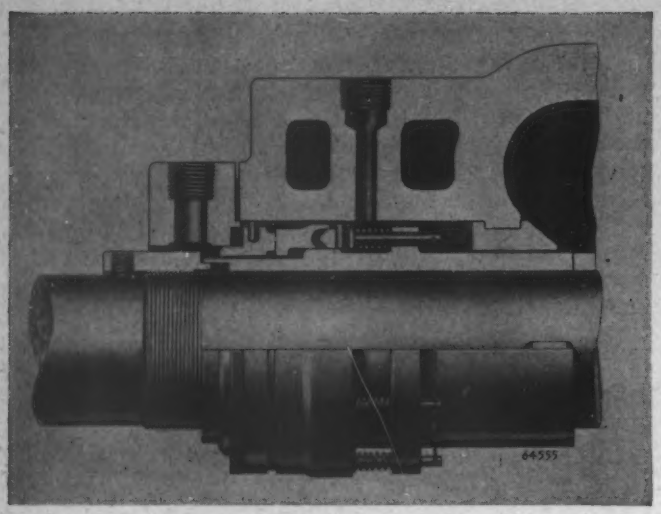


FIGURE 4
Simple mechanical shaft seal for standard conditions.

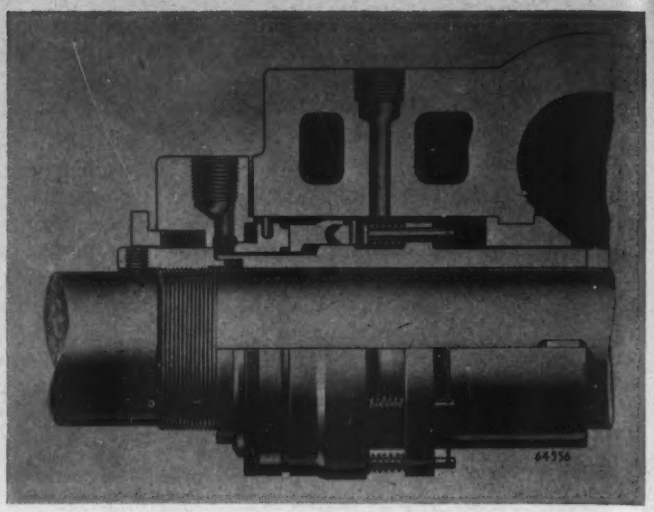


FIGURE 5
Mechanical shaft seal for light hydrocarbons.

and rugged qualities of a slow-moving, reciprocating pump, and the refinements which have had to be built into them to make them suitable for pumping volatile hydrocarbons seems not to have offered any complications not readily understandable by the average operator. In fact, the older men seem to favor them, perhaps because of long acquaintance with the general type and the feeling that they can see and, therefore, readily take care of any ordinary operating difficulties. The close-clearance features tend to make the pump more economical in use of steam than the conventional type, for obvious reasons.

Packing Troubles With the Earlier Centrifugals

Another of the perennial arguments between centrifugal pump manufacturers and operators has been in the matter of preventing leakage from shaft packing. Here again the operator wanted to apply the same remedy to a leaking gland which it had been his custom to use on reciprocating pumps—increase the pressure on the packing by taking up on the gland nuts. With the relatively shallow packing boxes of the earlier centrifugals, this practice got him into immediate trouble, especially with lighter oils which had no lubricating properties. The lubricant in either fibrous or semi-metallic packing soon washed out with the result that tightening the packing to the point of stopping all leakage put a first class prony brake on the shaft which then soon heated up and began to smoke. Sight of the smoke was enough to scare the operator into slacking off on the gland and permitting the box to leak pending the time when the packing could be renewed. Deepening the stuffing box and use of lantern gland provided with facilities for constant lubrication helped considerably, but the necessity for constant attention to the lubrication was an annoyance to the operator and added to the prejudice against the centrifugal. Two-pole motor speeds and higher discharge heads were additions to the difficulties of the problem. Needless to say, the abrasive action on the pump shaft within the packing area was enormous. Special hard-alloy sleeves reduced shaft replacement but did not do away with the trouble, because the packing material itself continued to wear rapidly, requiring frequent renewal.

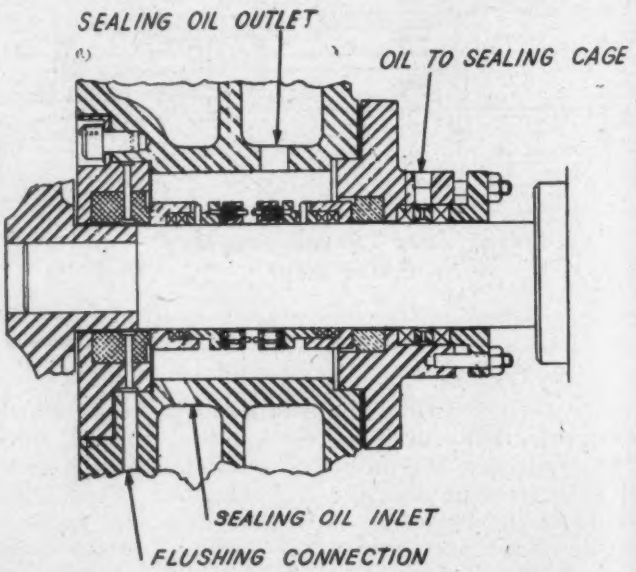


FIGURE 7
Showing graphically how flushing oil is used in bottom of the box and seal oil in the center to prevent acid reaching seal faces.

Illustrations on this page courtesy Ingersoll-Rand Company

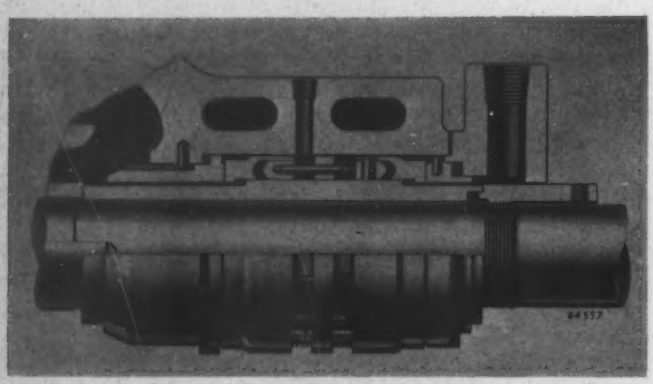


FIGURE 6
Double seal as used in hydrofluoric alkylation plants.

How the Problem Was Eventually Worked Out

In the manner by which the difficulty was finally overcome can be seen just another instance of the maternal characteristic of necessity. In working through the difficulties of hydrofluoric acid alkyla-

tion one of the major bugs was the imperative necessity of insurance against leaks. The hydrocarbon-acid mixtures were not destructively corrosive to available metals, but were corrosive to the human skin to a dangerous degree, therefore, a leak was not to be tolerated. All that was required, for one manufacturer at least, was to approach the problem from the angle of a proper evaluation of success in the matter, and to forget that too many people think of a centrifugal pump as a cheap piece of machinery, the shaft sealing of which is to be accomplished simply by stuffing wadding of one class or another into a box around the shaft and calling it a seal. When the job was approached somewhat as a steam-turbine designer provides against loss of vacuum at the last stage of a condensing turbine, by combination of mechanical seal with such auxiliary devices as are made necessary by individual conditions, the result was complete success, albeit not cheap.

Figure 4 shows a patented seal for standard pipeline conditions. This is the simplest type but does not fulfill the conditions set up by volatile fractions, such as butane and propane, with no lubricating properties.

Figure 5 is much the same as the standard pipeline seal except that it is adapted to seal light hydrocarbons such as propane and butane. It is claimed for the Cameron seal that, once assembled in the stuffing box of a pump and set for its operating condition, it requires no further adjustment. The seal is partially in hydraulic balance and constant pressure between the sealing faces is controlled. This means that the actual pressure existing between the sealing faces is comparatively low and for this reason it can be used for high stuffing-box pressures and for liquids such as propane and butane. No outside lubrication is needed for this seal unless there are corrosive elements in the liquid. Note that both the rotating and sealing members of this seal have a flexible mounting which allows them slight freedom of movement to insure proper contact in the alignment of the sealing faces.

The range of operation of this seal is roughly as follows:

A. Box pressures up to 400 pounds per square inch when handling cold liquids with poor lubricating properties.

B. Box pressures up to 600 pounds when handling cold liquids with some lubricating properties.

C. Box pressures up to 400 pounds accompanied by temperatures up to 250° F. when handling liquids with slight lubricating properties.

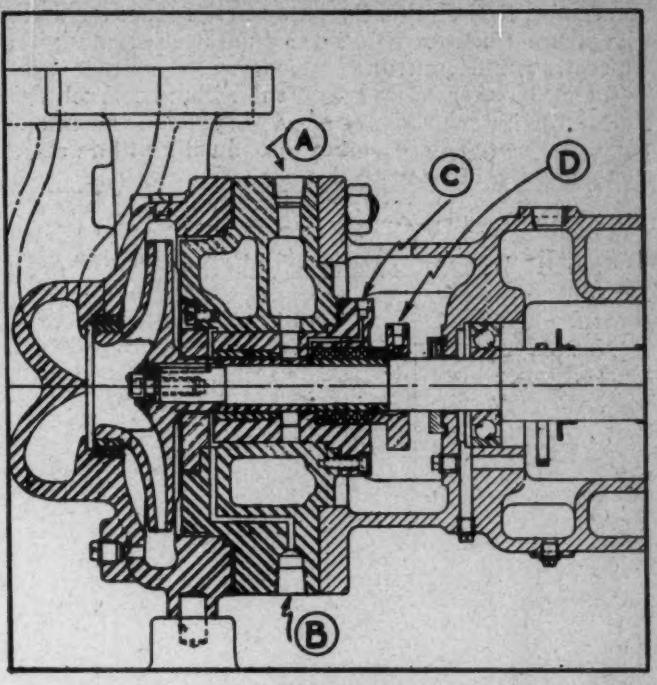


FIGURE 8

Arrangement used on pumps which do not have special mechanical seal.

Figure 6 shows the double mechanical seal as it has been developed and is being used for handling liquids containing a corrosive element. In hydrofluoric alkylation plants it is true, in a general way, that the pumps handling the highest hydrofluoric acid content have the lowest suction pressures, averaging around 70 to 80 pounds per square inch, with a discharge pressure approximating 400 pounds. Quantity handled is of the order of 150 gallons per minute. Seven-stage centrifugals are generally used, running at two-pole motor speeds, or just below 3600 revolutions per minute at 60 cycles.

Figure 7 brings out graphically the manner in which the flushing oil is used in the bottom of the box and seal oil in the center, so as to prevent any possibility of the liquid containing the acid reaching the seal faces.

Other steps in the hydrofluoric alkylation process, which involves the special seal, handle light hydrocarbons of a specific gravity of about 0.53 in which there is much less acid present and where the differential between suction and discharge pressures is lower, around 200 pounds per square inch. The volume duty is also lower than the other pumps, approximately 120 gallons per minute. Six-stage pumps,

FIGURE 9

The in-line pump.

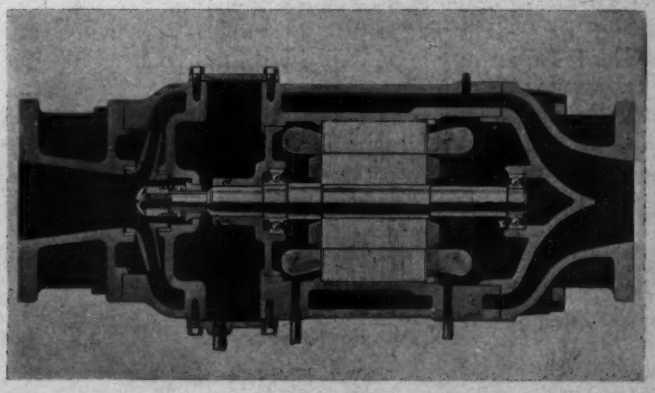


FIGURE 10

Courtesy A. O. Smith Corporation

therefore, handle this duty and are frequently driven by steam turbines to secure maximum flexibility of operation and control.

Figure 8 is of an arrangement which has been used on pumps which did not have the special mechanical seal. Note that here again both flushing and seal oil have been used. The flushing oil is injected at point B in a dead end annular space, and this flushing oil gradually leaks through the throat bushing sleeve, part 5, to the point where it balances against the seal oil which is injected at point A. Additional seal oil is injected at point C and grease can be injected at point D, if necessary. This device is not to be considered as a substitute for the double mechanical seal in the more important services. It performs satisfactorily, however, where there is no corrosive element in the oil, where pressure differentials are not high and with hydrocarbons or fractions of specific gravity higher than butane.

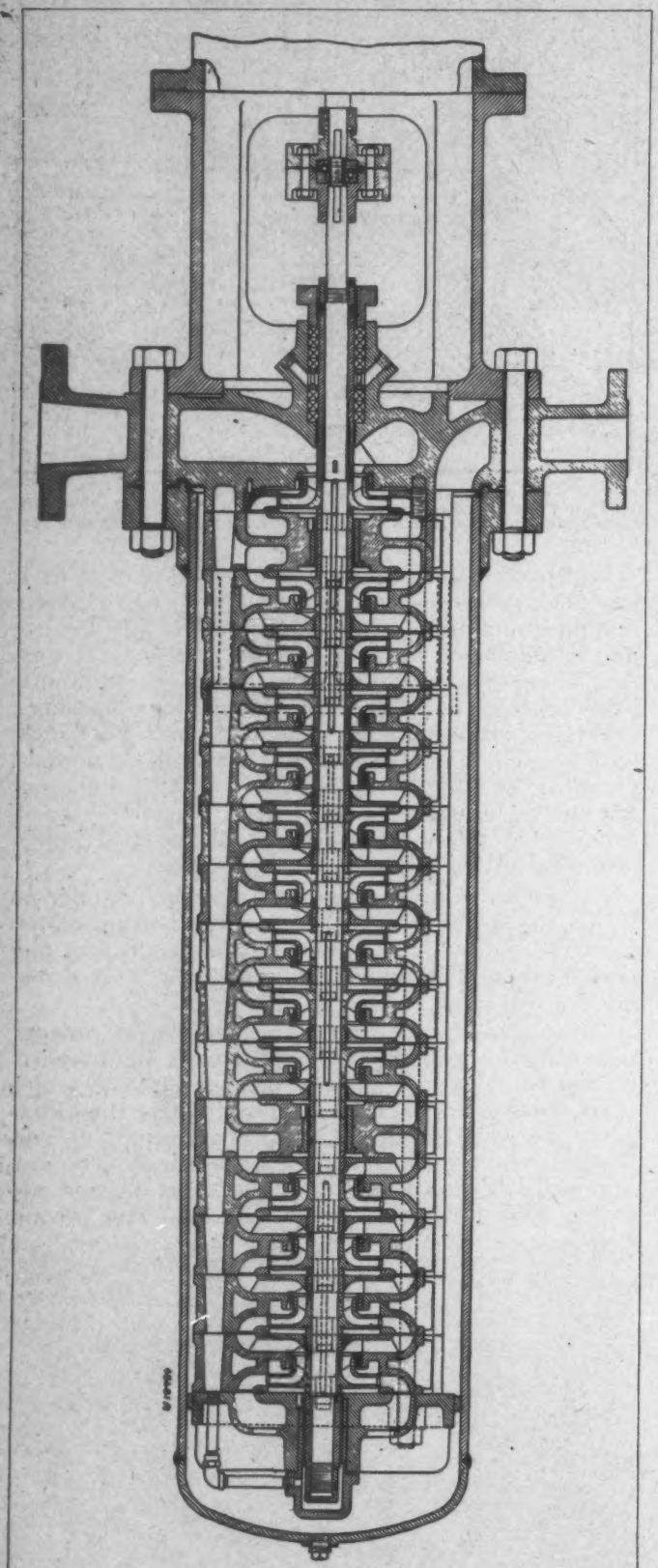


FIGURE 11

Multi-stage vertical centrifugal for light hydrocarbons.

Courtesy Ingersoll-Rand Company

The In-Line Pump

There is still another type of pump, the fundamentals of which are, by no means, new, which had proved to be very useful for many refinery, pipe-line and natural-gasoline-plant services, where the operating conditions are such that the few, but definite, limitations of the pump can be met.

The design of this unit is really an outgrowth of two other ideas, each of which had definite advantages, but neither, in itself, was considered suitable for the duty under discussion. The idea of simplifying a centrifugal pump by placing the impeller on an extended motor shaft has always been attractive and, after the usual period of eliminating bugs, has come to be a popular and widely used pumping implement. The main retarding factor in its development was the very same thing which holds back many other good ideas—undue emphasis on cheapness. This type of pump is now available for many refinery and natural-gasoline-plant duties but, in the conventional design, is not to be recommended for handling light fractions for reasons which should be too odvious to require discussion.

The other idea which has been incorporated in the in-line pump is based upon the general rule that the capacity of an induction motor to do work is limited chiefly by the ability of its windings to withstand heat. Following this reasoning, if the heat built up in the frame of the motor by the work being done, is carried away, then the power capacity of the motor is substantially increased.

The pump illustrated in Figures 9 and 10 has made use of both the ideas just mentioned and seems to have developed into a piece of equipment which should find wide use where the temperature, pressure, head and volume duties are suitable. Obviously, the unit offers minimum turbulence and friction and can be installed in any position in the line. It is presently being used with marked success for light fractions and for oils up to 200° F. and for heads up to 180 feet. We understand that capacities of 350 gallons per minute are being handled.

In conclusion, the writer makes the statement that the petroleum processing of the future cannot and will not tolerate adherence to some of the customs which exist for no reason other than a blind demand to do everything as cheaply as possible and to follow piping practices, for example, which have become traditional with other processing conditions and with other equipment. The petroleum industry has demonstrated its ability to meet and overcome the enormous demands which have been made upon it during the present period of national and international emergency. Let us maintain that reputation after the emergency, lest we lose the prestige we have gained and be forever behind the eight ball.

Typical Installation of Mass Spectrometer.

Use of the Mass Spectrometer In the Routine Analysis of Refinery Gas Samples

J. G. SCHAAFSMA, General Petroleum Corporation

Before the California Natural Gasoline Association, Los Angeles, March 2, 1944

UNTIL recently routine gas analyses at the Torrance refinery of General Petroleum Corporation of California were adequately handled by four low-temperature fractionating columns with acid adsorption trains for olefin determination. When construction was begun on new plant facilities to meet the growing demand for petroleum products, it became evident that it would be necessary to provide for a large number of additional gas and liquid streams. After due consideration of factors such as initial cost, accuracy, elapsed time, and man-hours required per sample for various types of equipment, a mass spectrometer was installed which now handles all the gas samples. Normally liquid samples, such as gasolines, are still run on the older fractionating equipment. Experience with the instrument over a three-months period has demonstrated that it is very satisfactory for routine refinery control work in all processes involving light hydrocarbons.

This paper will include a very brief discussion of the theory and operation of the instrument, and of its performance when used to control an acid alkylation unit.

General Theory

The mass spectrometer is so named from certain similarities it possesses to an optical spectrometer. The latter separates a light beam into its component monochromatic beams by deflecting shorter wavelengths more than longer ones; while the mass spectrometer separates a beam of moving gas molecules of various types into distinct beams according to mass, the presence and relative percentage of each mass being recorded. In order to secure this unusual effect, the gas in first ionized and the resultant ions given a high linear velocity by the action of an electric field (between e, f, and g in Figure 1). This, of course, is done in a high vacuum. Like any other charged particles, the ions can be deflected from their path by passage through the field of a strong magnet. While in the field their paths are curves whose radii of curvature are smaller for the low masses than the high ones. By gradually lowering the electric field producing the initial acceleration, while maintaining a constant magnetic field, the radii of curvature can all be simultaneously and continuously reduced during the course of a run. This

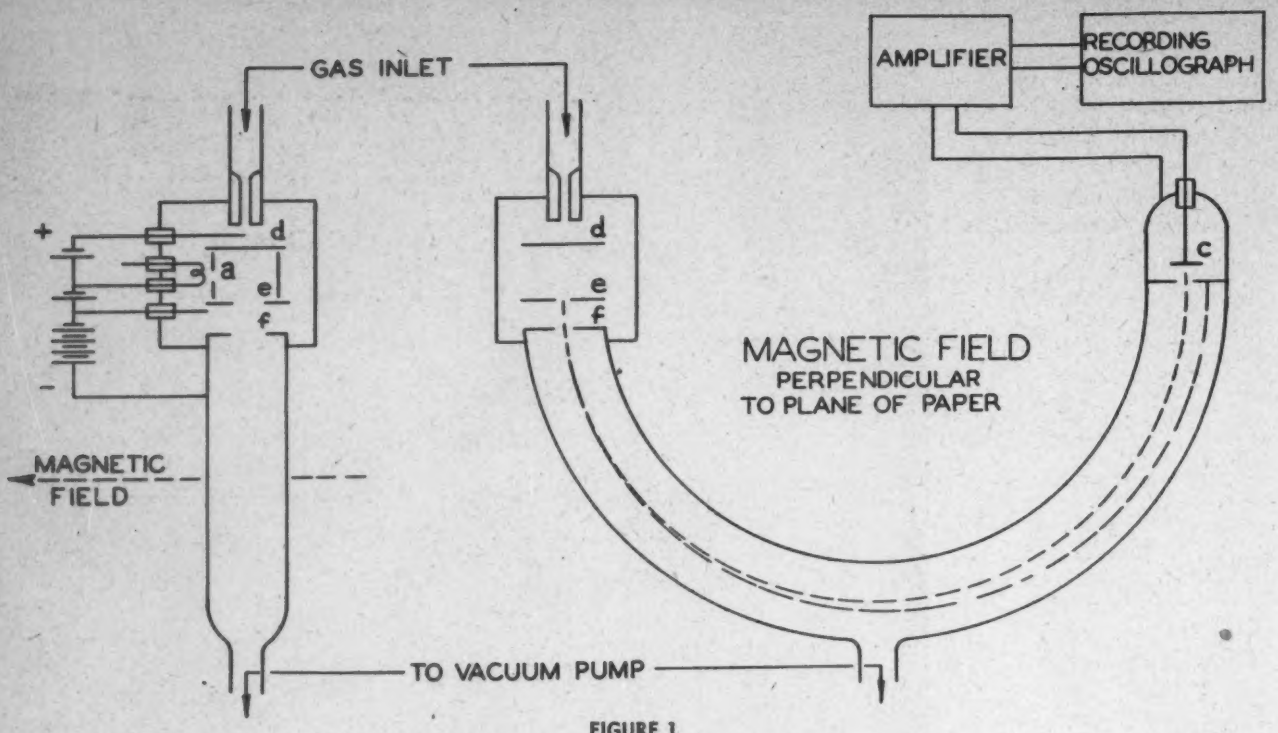


FIGURE 1
Schematic diagram of 180° mass spectrometer.

means that each mass in turn will have just the right curvature to pass through a semi-circular tube into a slit, and be measured. By keeping the inlet flow rate of gas constant, a record of each mass and of its relative amount can be obtained.

The above procedure would be sufficient if it were not for the existence of isomers of equal mass, such as normal and isobutane. In practice the ionization is severe enough to cause partial cracking of the molecules into fragments of lower mass. Each pure hydrocarbon has its own distinctive spectrum, or cracking pattern, as is illustrated by that of normal butane in Figure 2. Here the parent peak, corresponding to the molecular weight of 58, is plainly evident, as well as peaks due to the decomposition products. The degree of cracking is sufficiently different for each compound to permit the accurate analysis of mixtures containing isomers.

The actual running of a sample is a fairly simple procedure, involving manipulation of a few stopcocks and switches. Scanning and recording of the spectrum is almost completely automatic, the operator's main duties being that of putting a small portion of the gas sample into the inlet system, setting the accelerating voltage at the proper level before the run, and developing the photographic record after the run. Since the various electric circuits, such as the magnet and filament currents, are left on continuously, very little time is required in preparing for the next run.

Scope of the Instrument

Any light hydrocarbon mixture can be analyzed providing the pure constituents are on hand for calibration. At first only samples essentially free of C_5's were run on General Petroleum Corporation's spectrometer, but now isopentane, n-pentane and total pentenes are regularly determined. Traces of C_6's (.1 to 1.0 percent) occur in some of the gases, and can be estimated with sufficient accuracy without going through the complete calculations required to separate these components. Any samples containing larger amounts of C_6's and heavier are still run on the older fractionating equipment. The presence and percentage of oxygen and nitrogen can be accurately obtained, and as time permits, it is planned to try analyzing for hydrogen sulphide, and the light mercaptans as well. CO_2 interferes badly with certain hydrocarbon peaks and is removed beforehand. Water cannot be determined because of its absorption on the glass walls of the apparatus. The accurate separation of hydrogen and methane is easily made, whereas the older equipment gave only an approximate split.

Accuracy

From experience gained to date it appears that the spectrometer is at least as accurate in all respects as a very carefully operated fractionation and acid-absorption system, and considerably better than the latter as ordinarily run in routine control work. Table 1 contains comparisons between the two methods of analysis for two refinery gases and a spectrometer analysis of a synthetic mixture of known composition. Results obtained by the spectrometer check very closely with the analysis of the synthetic mixture and with results from conventional gas analyses. Another test is shown in Table 2, in which a synthetic mixture was made up and run through the spectrometer. Other work has demonstrated that the spectrometer can determine small amounts, say 0.1 to 0.3 percent, of heavy ends, such as pentanes or hexanes, in cases where the conventional method shows none present.

The mass spectrometer produces a permanent record practically independent of the skill and judgment of the operators, which is not true of older methods of gas analysis. In case results appear doubtful, it is only necessary to check the calculations and not the run.

Long and Short Methods of Analysis

Although essentially a scientific instrument capable of turning out very precise results, the nature of

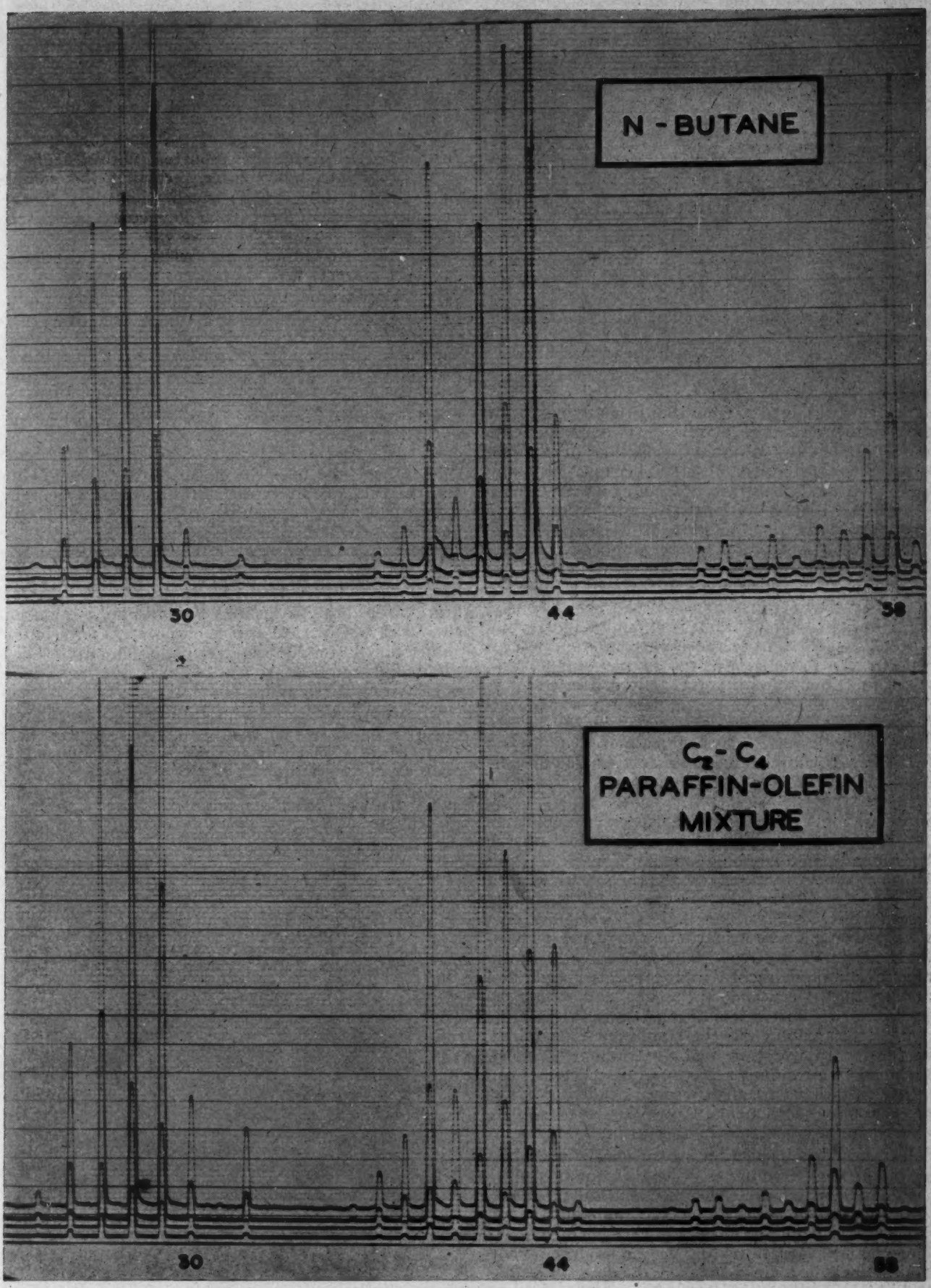


FIGURE 2
Automatic records obtained on the mass spectrometer.

TABLE 1

Comparison of Results of Gas Analyses by Combined Fractionation and Acid Absorption and by the Mass Spectrometer

Gas Analyzed.....	Cracking Unit Absorber Release Gas		Cracking Unit Stabilizer Release Gas		Synthetic Gas Sample	
Terrance Lab. No...	3069		3062		....	
	Mass Spectrometer	Fractionation and Absorption	Mass Spectrometer	Fractionation and Absorption	Mass Spectrometer	Actual† Composition
H_2S.....	not determ.	0.08	not determ.	0.22	....	....
N_2.....	1.6	....	0.2	0.00	....	....
H_2.....	10.7	....	0.2	0.00	....	....
Methane.....	56.1	66.70*	9.6	7.89	....	....
Ethene.....	2.7	2.37	1.8	1.69	....	....
Ethane.....	15.6	20.34	22.5	22.28	20.9	21.0
Propene.....	3.2	2.78	14.9	14.56	12.8	13.1
Propane.....	6.0	6.59	37.7	39.67	35.7	35.8
Isobutane.....	0.6	0.65	4.7	4.65	6.6	6.2
Isobutene }.....	0.4	0.38	3.7	3.78	4.7	5.1
N-butene }.....		0.11	2.7	2.79	6.9	6.4
N-butane }.....			2.0	2.47	12.4	12.4
Total.....	99.9	100.00	100.00	100.00	100.00	100.00

* Includes fixed gases. † Pure compounds blended, amounts added being read on a manometer.

the spectrum obtained is such that in many cases the approximate percentage of one or two components can be obtained by a rapid inspection of the developed record. This is possible because in many refinery mixtures there are compounds whose main peaks on the record contain no contributions from other compounds. The heights of these peaks are directly proportional to the percentage of the compound in the mixture, which makes their analysis very simple. A complete analysis is usually more involved than this because many of the peaks consist of contributions from a number of compounds. Again, however, the contributions of each compound are always directly proportional to its percentage, and much of the calculation involves only arithmetic. For the rigorous solution of a 14-component mixture consisting of a highly cracked gas containing all hydrocarbons through the C_4's as well as hydrogen, air and H_2S, the most complicated mathematics required is the solution of a set of three linear simultaneous equations.

Short methods of analysis are especially applicable where a refinery operation can be controlled on the basis of one or two key components. For example, in a depropanizer purifying isobutane the overhead need only be analyzed for isobutane and the bottoms for propane. Where such a case exists, two short cuts can be used which reduce computing time and instrument time, respectively. The first consists in obtaining a complete record in the spectrometer and obtaining the percentage of the key component by inspection or a short calculation. At any future time the complete analysis may be computed, if required, from the record which is filed. Instrument time can be reduced by scanning a part of the spectrum and securing only that part of the record needed to determine the key component. However, no complete analysis can be calculated in the future.

Calculation by inspection is especially useful in determining the percentages of small amounts (up to 5 percent) of undesirable heavy constituents caused by improper operation of refinery equipment. An experienced spectrometer operator can become quite proficient and accurate in this very useful short-cut, since the heaviest fractions, say hexanes, produce peaks which stand out by themselves and are due to no other compounds.

All of these partial analyses give the composition as mol percentages. In case the analysis of a liquid stream, say a C_4 cut, is desired in terms of liquid volume percentages, a complete analysis of the cut on a molal basis must first be worked out. It would seem desirable to convert refinery operations to a mol percentage basis wherever possible.

Elapsed Time, Man-Hours, and Samples per Shift

Depending on the type of gas and the accuracy desired, results can be reported within from 25 minutes to two hours after receiving the sample. Considerable time can be saved when only the approximate percentage of one key component is required by the refinery, since an experienced spectrometer operator can, in many cases, secure this figure by mere inspection of the photographic record.

Actual instrument time is usually under 30 minutes for all types of samples, but calculation times vary considerably. Accurate determination of a single paraffinic constituent varies from 5 to 10 minutes, depending on whether an isomer is present or not. Calculation for all components of a C_1 to C_4 paraffinic gas takes 30 minutes, and the presence of iso- and normal pentanes may add another 10 minutes. A cracked C_1 through C_4 gas requires about one hour's calculating time because of the presence of olefins, and the presence of appreciable amounts of pentenes may add from 15 minutes to 1 hour to the time depending on whether they are calculated as a total or as individual pentenes.

About one hour per day, prorated, is spent in calibration of the instrument. Actually, a complete calibration for all hydrocarbons need be run only once in two weeks, while a daily check is made on n-butane alone. This latter run requires under 30 minutes since the equipment is kept "warmed up" overnight when not running three shifts.

The shortest type of run is illustrated by the testing of a depropanizer overhead for isobutane inclusion. In this case instrument time is reduced by operating over a limited range of masses (from 40 to 60).

	Elapsed Time
Introducing sample	5 minutes
Making run	10 minutes
Developing	5 minutes
Calculation by inspection	5 minutes
	25 minutes

A complete analysis of a cracked gas containing no pentanes would require the following time:

	Elapsed Time
Introducing sample	5 minutes
Making run from mass 10 to mass 66	20 minutes
Making run from mass ½ to mass 4 (H_2 requires weaker magnetic field)	5 minutes
Developing	5 minutes
Calculation for all components	60 minutes
	95 minutes

This calculating time is for an expert well adapted to this type of work.

TABLE 2

	Synthetic Percent Comp.	Consolidated Calc. Percent	General Petroleum Calc. Percent
Methane.....	14.88	14.90	14.90
Ethane.....	19.96	19.94	20.05
Propene.....	10.07	9.98	10.10
Propane.....	20.07	20.14	19.92
Isobutane.....	9.97	9.96	9.87
Isobutene.....	6.99	6.67	7.23
Butene-1.....	5.03	5.07	4.82
Butene-2.....	4.98	5.38	5.05
N-butane.....	8.05	7.96	8.06

TABLE 3

Hydrocarbon Samples from Gas Plant and Alkylation Unit

Type of Analysis Used and Time Required When Alkylating Butenes and Pentenes Together

	Type of Analysis*	Key Components	Total Elapsed Time for Run and Calculations	
			Complete for All Components (Minutes)	For Key Components Only, Using Short Cuts (Minutes)
Gas Plant:				
Total Gas from SR and Cracking Units to H.P. Absorber	MS	n-pentane	105	45
Gas from H.P. Absorber	MS	C_4's	45	30
Gas from L.P. Absorber	MS	C_4's	45	30
Raw B-B Depropanizer Feed (from Gas Plant) incl. C_5's	MS	All	85	85
Raw B-B Depropanizer Tops	MS	C_4's	45	30
Raw B-B Depropanizer Bottoms, incl. C_5's	MS	C_5's	85	30
Raw B-B Debutanizer—Tops	MS	n-pentane	85	60
Raw B-B Debutanizer—Bottoms	....	pentenes	....	60
Alkylation Unit:				
Treated B-B to Contactors, incl. C_5's	MS	All	85	85
Recycle Isobutane	MS	propane and isobutane	60	40
Alkylate de-isobutanizer—Feed	Fractionation	C_5's, C_4's	480	....
Alkylate de-isobutanizer—Tops	MS	n-butane	45	35
Alkylate de-isobutanizer—Bottoms	Fractionation	isobutane	360 (through C_5's)	90
Alkylate debutanizer—Tops	MS	isopentane	35	25
Alkylate debutanizer—Bottoms	Fractionation	n-butane	300 (through C_5's)	90
Isobutane depropanizer—Tops	MS	isobutane	35	25
Isobutane depropanizer—Bottoms	MS	propane	35	25
Alkylate rerun—Tops	Fractionation	C_5's	....	120

* M. S. Mass Spectrometer: Fractionation—Low Temperature fractionation and acid absorption.

In addition to saving time through calculation by inspection, some savings are obtained if only total butenes, rather than the breakdown into isomers is desired. When most refinery operations are controlled on the basis of one or two components, and speed rather than extreme accuracy is desired, 2 operators and 1 calculator can turn out an average of 14 refinery samples containing C_1 through C_4 in an 8-hour day, when half of them are calculated by inspection. This is equivalent to 1.72 man-hours per sample. If all samples are to be accurately calculated for all components through C_4's, one more calculator must be employed and the man-hours become 2.28 man-hours per sample. The presence of appreciable amounts of pentanes increases the calculating time and hence the number of calculators needed. The number of samples per day put through the machine may be increased in certain cases when most of them can be run over a limited range of masses instead of over the whole range from C_1 through C_5.

Table 3 shows a list of samples from a gas plant and alkylation unit, showing time required for complete and for partial analyses. In order to better illustrate the range of samples that can be handled by the spectrometer, this example shows some pentenes included in the isobutane-olefin charge to the alkylation unit contactors, although this is not a general practice. Some of the streams containing appreciable amounts of hexanes and heavier are still run on the fractionating equipment, as they are at present considered too complicated for routine analysis by the spectrometer. However, other laboratories have analyzed certain C_6 and C_7 concentrates by means of the spectrometer.

Personnel

It is considered desirable to have two operators per shift for satisfactory performance and one or more calculators, depending on the type of samples run. In our case the operators are college graduates with considerable petroleum laboratory experience. It is desirable in any case for at least one person to have a good technical background and that all operators be chosen for their skill and technique in handling precision equipment. One operator puts the sample through the instrument and watches the controls, while the other connects and disconnects the sample bombs, develops the records and assists in the calculations as time permits.

At Torrance, calculations are handled by a girl with no training except first-year high-school algebra. Speed and accuracy are the desirable traits in this case, the calculations being detailed, but not at all difficult. About two months are required to break in a calculator, although much of the work can be picked up in a few days. An aptitude test might be advisable to be sure of securing persons well-suited for this work.

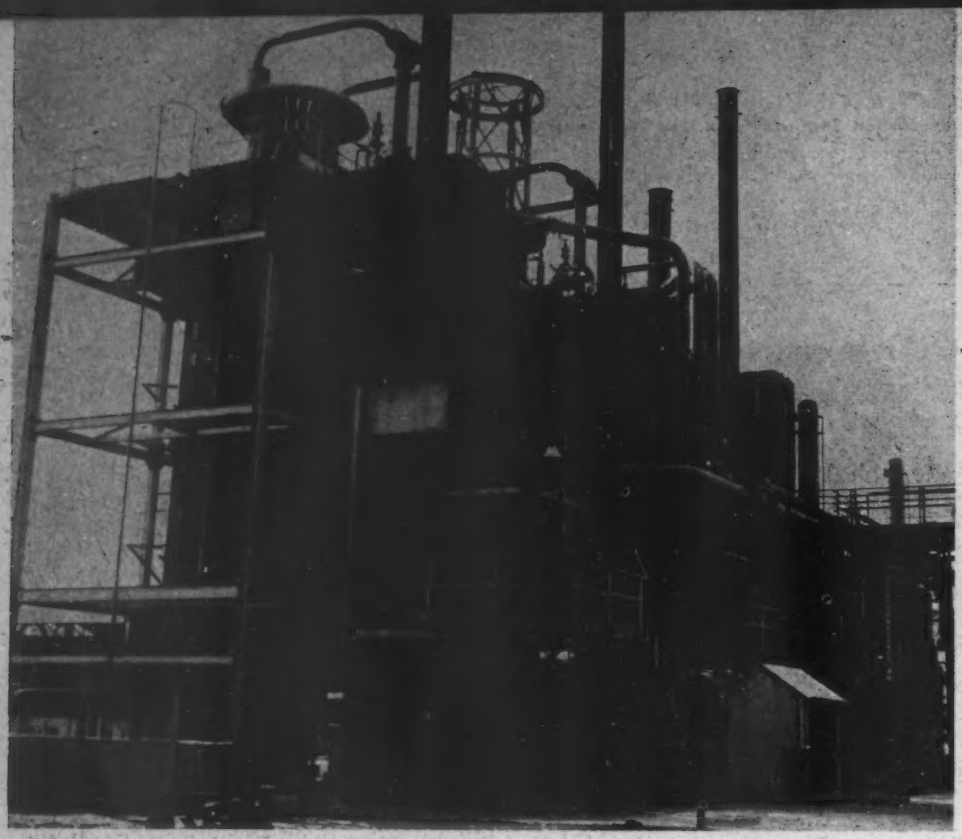
Maintenance work requires the part-time services of a skilled electrician. In our case repairs are made by a refinery electrician with the help of one operator who has familiarized himself with the various electrical circuits. In case of failure of the analyzer tube or a galvanometer, the repair work is done by Consolidated Engineering Corporation in Pasadena. Delays are avoided by keeping a spare tube and one galvanometer on hand which can be installed by the operators.

Sampling

Due to the extremely small amount of gas actually required for a run (less than 1 cc of gas at one atmosphere) the size of the sample is dictated by convenience. At Torrance six-ounce ICC cylinders are used for high-pressure samples and glass containers for gases at atmospheric pressure. Both types are equipped with two valves, for filling by water displacement.

Elsewhere in the literature may be found a more complete discussion of the technical details of the spectrometer and also the experiences of others in the use of the instrument.[1] The writer is indebted to D. J. MacLaren for preparation of the data used in this report and to the Consolidated Engineering Corporation for permission to publish this article.

[1] H. W. Washburn, H. F. Wiley, and S. M. Rock. I. and E. C. Anal. Ed., Vol. 15, No. 9, 541 (Sept., 1943). O. L. Roberts (The Atlantic Refining Company). Petroleum Refiner, Vol. 22, No. 5, 107 (May, 1943).



Dehydrogenation Reactor Furnaces

Operation of Synthetic Toluene Plant Made Public

WITH the lifting of rigid censorship restrictions on industrial developments on the West Coast, Shell Oil Company has been permitted to give general information on its Wilmington plant for making toluene synthetically. The petroleum industry rushed its plants to completion when it was evident that coal-tar processing could not provide sufficient toluene for TNT.

Part of the news release on the new plant and process follow:

"Toluene, basic ingredient of TNT, high explosive used in block-buster bombs, has generally been considered as a coal-tar derivative. But several years ago, research scientists of Shell Oil Company developed a secret process whereby this same vital material could be produced from petroleum. That was the start of the Shell toluene recovery process, now widely licensed in America, and the backbone of more than half of the nation's toluene production. This was followed by the development of a new and highly technical process for synthesizing toluene from petroleum. Shell's plants, alone, are now producing more toluene than the entire nation produced prior to the war.

"Following Pearl Harbor, the need for more and more toluene became a national problem. Without recourse to government funds, Shell Oil Company proceeded to build the first toluene plant in the West. Located at the company's Wilmington refinery, the plant was completed in record time at a cost of $4,800,000. In December, 1942, only one year after the outbreak of the war, the first nitration grade, or high purity toluene was produced. Production has exceeded the most optimistic advance estimates, and today the Wilmington plant is producing enough toluene, every 24 hours, to fill 700 giant block-busters.

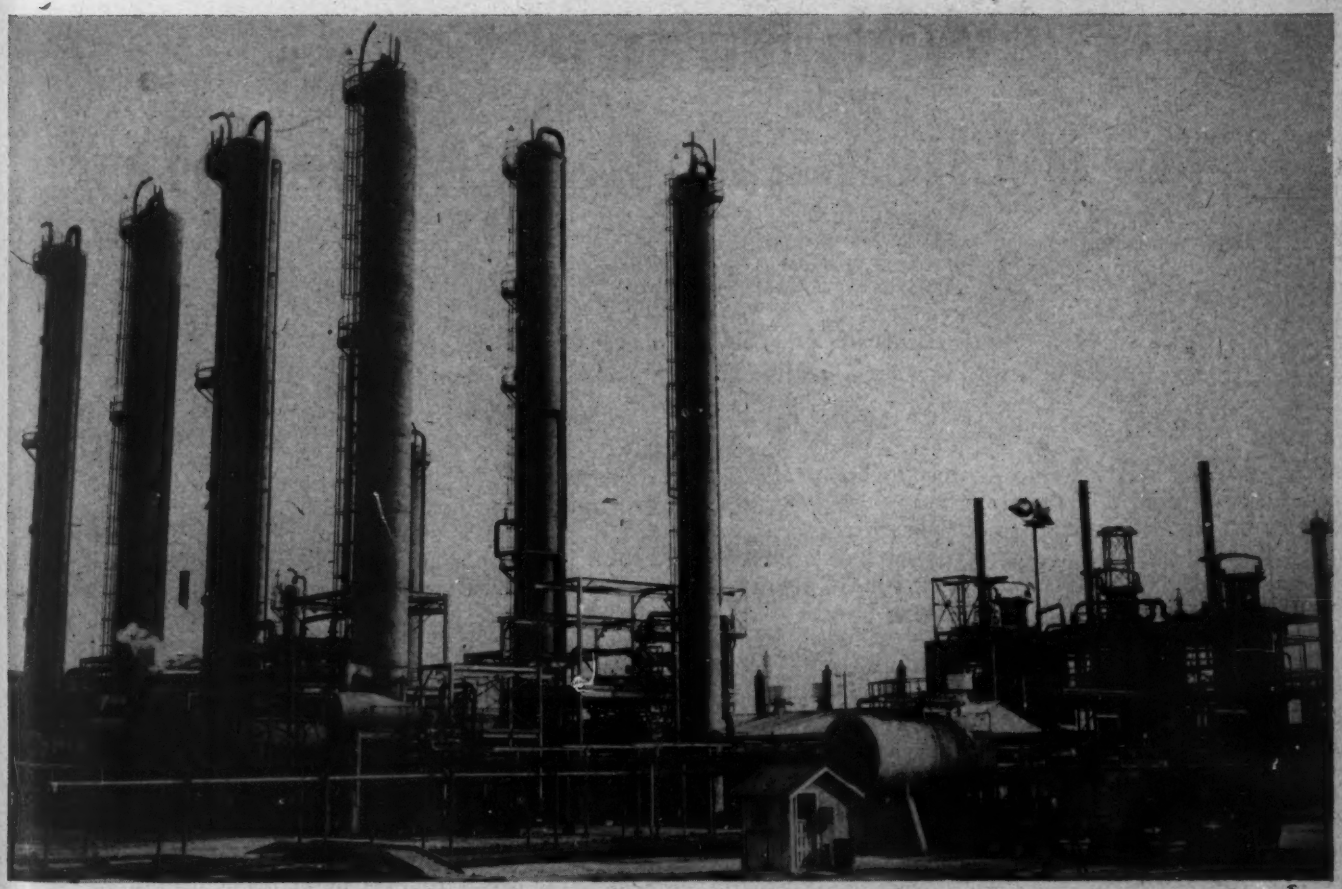
"From an efficiency standpoint, the process is unique in that practically no waste products result, being precisely tailored to produce a maximum quantity of toluene from a barrel of crude oil without unnecessary sacrifice in other products.

"Since December, 1942, the plant has been producing exclusively for the United States Army Ordnance, and officials have highly commended the oil company for its substantial contribution to the war effort."

Although toluene is still considered fundamentally an explosive ingredient, it is being shifted to 100-octane aviation gasoline as excessive output comes from refining plants. The versatility of the material is one reason for the continued expansion of aviation motor fuel output.

Since it also has wide applications as a solvent, toluene is one of the products of wartime necessity which promises to continue as a major petroleum product after its military uses have been reduced.

First photograph of the synthetic toluene plant of Shell Petroleum Company, Inc., Wilmington, California.



Feed pre-fractionation and solvent extraction columns.

Maximum Hydrocarbon Utilization With Natural Gas As a Chemical Raw Material

JAMES E. PEW, Director
and
FRANK H. DOTTERWEICH, Consultant,
Natural Gas and Natural Gasoline Division, Petroleum Administration for War*

THE growth of the gas industry during peacetime was accompanied by developments and operating problems primarily related to the use of natural and manufactured gas as a source of fuel and energy. While these activities were being given major attention, a new technology was being evolved—that of petro-chem development, in which gaseous hydrocarbons were being distorted, rearranged, and recombined to yield chemical raw materials from which useful products could be manufactured. Today the swift tempo of war activities places increased emphasis upon these petro-chem operations, capable of supplying our tremendous war machine with vital war products, many of which find natural gas as the basic raw material.

The wartime developments are not of a static nature but will progress steadily until the not-too-distant day when a substantial portion of our hydrocarbon derivative chemical products will have their origin in natural gas. This paper will endeavor to note processes presently available, together with those which will become generally available in the postwar period by means of which we may hope to utilize more efficiently the full range of our hydrocarbon raw material and, in addition, to analyze the effect of these petro-chem operations upon present and postwar activities of the gas industry. The future of natural gas in its capacity as a chemical raw material has occupied much space in technical publications and general discussions, and this subject continues to grow. This is true, at least in part, because of the rapidly advancing technologies, which appear

* Presented before the Southern Gas Association, New Orleans, Louisiana, March 23, 1944.

destined to have profound effect upon the future of the industries involved. Natural gas is known as the ideal fuel with its superb performance bringing about the development of special heating and cooling equipment and thus furthering the earlier standardized applications, such as cooking and heating.

The stability of the gas industry and, more particularly, the natural gas section, has been built around a numerically substantial domestic load, which condition has permitted it to weather the storms of depression. In looking into the future the question arises as to what effect petro-chem developments are to have upon this industry. Naturally this problem resolves itself into, first, an analysis of available natural-gas reserves; second, a consideration of the success of new commercial processes proposed with natural gas as their chemical raw material; and, third, a quantitative study of the extent to which the use of natural gas therein will deplete those reserves.

Natural Gas Reserves

Natural gas reserves are today estimated at 110 trillion cubic feet. With marketed natural gas production approximately 3¼ trillion cubic feet in 1943, a supply sufficient for the next 30 or more years appears to be definitely assured. This compares favorably with an estimated oil production known reserve ratio of 14 years.

A further evaluation of relative importance of natural gas in the natural resources picture is provided by a comparison of natural gas and oil reserves, on a thermal or weight basis, either of which reveals their near equivalence. Probing more deeply behind these reserves figures, it may be determined that estimates of natural-gas reserves have risen phenomenally in less than 10 years. A 1935 estimate of 62 trillion cubic feet of gas reserves appeared optimistic beside others at that time; yet, in the ensuing 9 years, during which more than 25 trillion cubic feet of gas have been withdrawn from the nation's underground reservoirs, reserves estimates have risen to the present 110 trillion cubic feet for the nation.

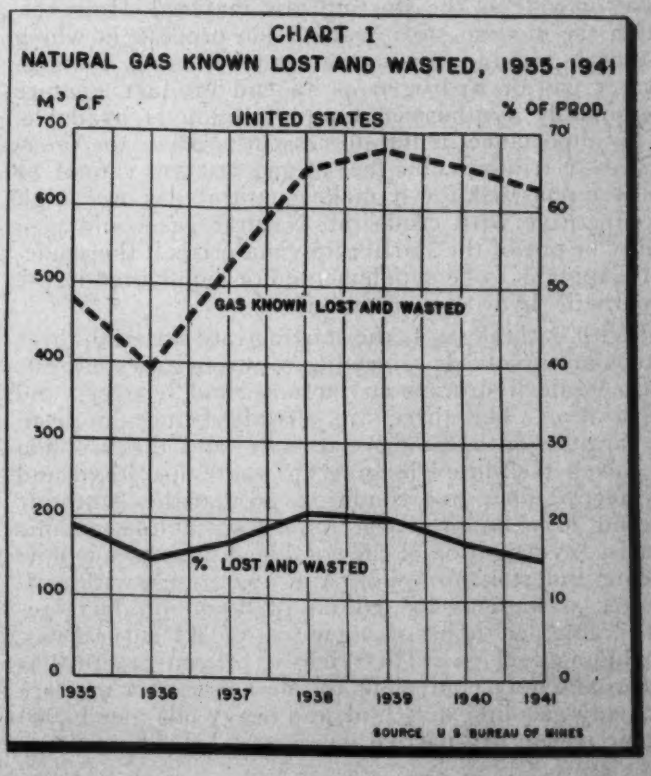
Meanwhile, an analysis of discoveries in the highly active area embracing South Arkansas, Louisiana and the Coastal Plain of Texas reveals further that, in the years between 1934 and 1943, the proportion of gas and gas-condensate to total discoveries rose from 24 to 52 percent, with gas-condensate discoveries largely uncovered in deeper drilling increasing from 11 to 36 percent of the total during this period. The continuance and expansion of this deeper drilling program, undertaken as improvements in technique permit, may be expected to uncover an increasing proportion of fields of the gas-condensate type, existing under extremes of pressure and temperature, and these fields, productive of the lighter hydrocarbon fractions which are proving so valuable in wartime production programs, through the installation of cycling equipment may constitute the nucleus in the postwar period of the new petro-chem technology. So much is already evident: the period and magnitude of gas-condensate discoveries is adequate to justify appreciable capital outlay, as increasing amounts of the lighter hydrocarbon materials will be made available for chemical processing and, potentially, manufactured-gas enrichment. The latter, gas enrichment with ethane-propane mixtures, should be given immediate attention by manufactured gas companies, if the advantages of a higher Btu gas of non-gumming and non-corrosive properties are to be attained.

But the gas industry has still greater possibilities ahead. The uses of natural gas to be hereinafter described are new uses, providing new markets. Gas companies possessed of a high degree of engineering skill and knowledge, with a fundamental awareness of the capabilities of their stock-in-trade, could look upon the new technology as an added source of revenue.

It is necessary to emphasize that a new market has been created for, as shall be seen, the needs of the United States for certain products in 1943 could have been met through conservation of natural gas reported lost and wasted by the United States Bureau of Mines in the 1942 Minerals Yearbook, carrying most recently published analysis of gas disposition (1941). Actual production exceeded 4 trillion cubic feet, with almost one third of this being divided between repressured and stored gas (660 billion cubic feet) and gas known lost or wasted (630 billion cubic feet). The latter figure will be used in the calculation to follow as being both qualitatively and quantitatively indicative of the magnitude of this waste. Gas loss and waste in proportion to production is decreasing as indicated in Chart 1, but the figure is still far too great, despite the intensified efforts of the governing legislative bodies to reduce it to the absolute minimum.

New and Proposed Commercial Processes

The importance and value of natural gas at present and, in the postwar period, to an ever greater extent, is a measure of the volume available and low critical material requirement for processing and production. By modern methods of extraction and fractional distillation, natural gas may be separated into relatively pure saturated hydrocarbons. Valuable in their pure state as blending agents or, when specially processed, still more valuable as a chemical raw material, giving remarkably high yields of war products. Among these are high-octane aviation gasoline, synthetic rubber, explosives and plastics, all being made in great quantities with petroleum and natural gas



as key components. Too, new processes and products are constantly undergoing development, and natural gas will continue to grow in importance as a chemical raw material.

In discussing the newer methods of conversion, not only into the essential raw materials, but also into the final products, it appears desirable to divide these into (1) processes directly concerned with the production of superior liquid fuels from natural gas, and (2) processes concerned with the production of other chemical raw materials.

Liquid Hydrocarbon Fractions from Natural Gas

Such hydrocarbons as propane and butanes occur in appreciable quantities in wet or casinghead gas, and are largely removed before the gas is marketed. At the present time propane-butane fractions serve as liquefied petroleum gases and also as feed materials from which certain aviation-fuel components are derived. Production of super aviation fuels, composed of select hydrocarbon fractions in definite proportions, requires large quantities of iso-octane alkylates, cumene, tetraethyl lead, and other essentials. An appreciable amount of these ingredients has its origin in natural gas—in fact, a finished aviation fuel may be produced altogether from fractions obtainable in exploitation of the nation's gas-condensate fields.

Production of liquid hydrocarbon fractions from dry natural gas is presently receiving attention. Processes involved have been developed commercially by European powers and are related to those through which Axis nations are now synthesizing gasoline from coal. The increasing reserves of natural gas in this country, viewed in conjunction with heightened consumption and decreased finding power of crude oil, are presently accelerating interest on this subject.

In the past, liquid hydrocarbon fractions have been prepared by a process commonly referred to as the Fischer-Tropsch process. In this process, water gas (carbon monoxide plus hydrogen) is the raw material. In Europe water gas has been prepared with coal or coke as the starting raw material. However, with the modern steam conversion process, in which natural gas and steam are made to react to form water gas or hydrogen as an end product, a more reasonably synthesized liquid fraction is available. The importance of the process in relation to America's 110 trillion cubic feet of gas reserves cannot be overemphasized for it makes natural gas well-nigh competitive with crude oil. Natural gas could possibly be one of the starting raw materials if the crude-oil supply is to be supplemented or supplanted in the synthetic hydrocarbon fractions.

With natural gas as the starting raw material, three steps are involved: reforming to water gas, synthesis into liquid hydrocarbon fractions, and recovery and separation. The three are already being practiced separately on a commercial scale, and the problem resolves itself into "flanging up" these operations and perfecting operating conditions so that this synthetic liquid may be produced on a favorable economic basis. Investigation of the combined processes is now being undertaken in pilot-plant operations, with estimates as high as 4.2 gallons of liquid products recoverable per thousand cubic feet of dry natural gas, including fuel gas. This yield if proven practical is approximately equivalent to one barrel of a mixture (chiefly gasoline, diesel oil, and heavy oil), per 10,000 cubic feet of dry natural gas.

Chemical Processes—New and Proposed

Chemical developments related to natural gas are numerous, and progress is being made constantly. In this paper major attention is to be directed to the preparation of products derived from natural gas which serve as chemical materials from which many useful products may be derived.

The steam conversion process, to some extent developed in this country, is outstanding because it reforms dry natural gas to water gas or hydrogen. Water gas, in addition to being the base product in manufacture of liquid fuels may be the starting point in production of synthetic alcohol and formaldehyde. War and peacetime uses of hydrogen are many, but chief among them is the production of synthetic ammonia for use in explosives, fertilizers and hydrogenation processes (principally in the production of super fuels).

The regenerative furnace process makes available still another method of cracking natural gas. This furnace, now ready for commercial operations, produces important starting chemical materials, such as acetylene, ethylene and propylene from natural gas constituents, not excluding methane, but with ethane and heavier fractions more desirable. Still another method is provided in the electrical production of acetylene. This method is being thoroughly investigated in pilot-plant operations, and may be expected to be of importance in the postwar production of acetylene.

Production of carbon black, of fundamental importance to the rubber, printing and paint industries, has long utilized about one tenth of this country's annual production of natural gas through the simplest of chemical reactions into which methane, the principal component of natural gas, enters—combustion and thermal decomposition. Carbon black is today being prepared from natural gas alone in channel and roller plants (typical of contact methods of manufacture), and thermal and furnace plants. A product similar to the furnace type is also being prepared from degraded oil and natural gas in combination. It is interesting to note that the thermal production of carbon black had its origin in the derivation of hydrogen, from natural gas, with the thermal black representing merely a by-product. It is, then, possible to obtain two products through one process. Production of hydrogen is alone economically feasible, even in areas of high gas cost; the relatively cheap, coarse grade of carbon black obtained, capable of being used in extremely high loadings, represents additional revenue.

Oxidation process is now in commercial operation, with natural gas serving as a raw material in the production of formaldehyde, methyl alcohol, acetone and acetaldehyde, among others. Present processes yield a mixture of these oxidation products, and economics require that the market absorb all of these derivatives if the high cost of production is not to be imposed upon any one end product. It is possible that more recently developed processes now undergoing examination will permit conversion of natural gas exclusively into one product, thus eliminating economic uncertainty. (The subject of producing oxy-hydrocarbon derivatives by alternative method is considered elsewhere herein.)

Cholorination of natural gas and its derivatives to form chlo-hydrocarbon solvents is of proven commercial importance, while their use has been greatly

increased in wartime. The peacetime uses of these compounds have been greatly curtailed or eliminated in order that they may be made available for war uses. These compounds are of great importance, both in chemical warfare and in the synthetic rubber industry, as well as in many other uses demanding near or absolute non-flammability plus excellent solvent power for oils, fats and other organic materials. Improved processes of this type are continually being developed, and natural gas will remain one of the important raw materials.

Vapor-phase nitration of natural-gas hydrocarbons on a commercial-plant basis has produced the four nitroparaffins; nitro-methane, ethane, propane and butane, thus making available for chemical synthesis a group of compounds with a potential range of usefulness unequaled by any other new group of organic chemicals. These compounds are more than just another group of new compounds because they open an entirely new field of organic chemistry, a field which someday may rival development of the coal-tar derivatives in magnitude and scope. At the present their entire production is going into essential war uses for the synthesis of pharmaceuticals, dyestuffs, insecticides, rubber chemicals, photographic developers, textile chemicals and resins, together with their use in solvent applications. The entire postwar industry, particularly the highly specialized industries, should find these nitroparaffins a fertile source of improved and new chemicals for new and better products.

In addition to being of great importance as a raw material in the processes previously cited, natural gas is forging ahead along other lines. An example is the production of carbon disulfide, presently derived by heating sulphur and charcoal. Recently published laboratory research indicates that high yields of carbon disulfide may be obtained through the high temperature reaction of methane and sulphur, and that methane and other hydrocarbons offer possibilities as cheap raw materials in this production, such new processes making use of natural gas as a chemical raw material, are introduced daily.

Quantitative Requirements of Natural Gas in Its Capacity as a Chemical Raw Material

Diversified opinions have been voiced regarding the magnitude of demands which may be made of natural gas in its capacity as a raw material for the rapidly developing petro-chem industry. The view most generally held, and one in which the authors have concurred, is that demands will be slight by comparison with the enormous volumes annually used for fuel. An attempt has accordingly been made in the following paragraphs to evaluate these demands quantitatively, based upon production figures for various organic chemicals which were synthesized during 1943. As will be shown, all of these could have been produced with a fraction of the natural gas loss and wastage to which reference was earlier made.

Methane is suitable for the production of acetylene, particularly by electrical methods, and may also be used in the steam conversion process whereby formaldehyde or methanol may be obtained. With these possible exceptions, ethane, propane, and butane provide more desirable raw materials. Accordingly, use has been made of these fractions in the following study, with the lean gas then being converted into methanol and formaldehyde sufficient to fulfill the requirements of these products, and the remainder entering into the synthesis of liquid hydrocarbon fractions by means of the Fischer-Tropsch process. The conversion factors used are not improbable for the early postwar period.

In the recovery of the heavier hydrocarbon fractions from natural gas, their conversion into basic chemical raw materials, and their subsequent synthesis into organic liquids, the latest available recovery and yields were used. Inasmuch as part of the data is restricted, total requirements are given rather than any detail.

Reference to Table 1 divulges that the estimated production of these synthetic organic chemicals, as listed, could be derived largely through regenerative cracking from the recoverable ethane, propane and butane content of 480 billion cubic feet of gas (about 75 percent of the gas reported lost and wasted in 1941). The residue dry gas could then be synthesized into 44.4 million barrels of a gasoline, diesel oil, and heavy oil mixture. An alternate method, illustrative of the diversity and flexibility of available processes, is considered in Table 2. This method is constructed chiefly around oxidation processes presently being employed in the conversion of natural-gas derivatives to certain basic chemical raw materials of use in the war effort. The synthetic organic chemicals indicated could be produced, again, from the reported 630 billion cubic feet of gas loss and wastage in 1941, with the remaining semi-dry gas available for synthesis into approximately 55.5 million barrels of a gasoline, diesel oil and heavy oil mixture.

Notably, also, production of the majority of synthetic chemicals itemized in Tables 1 and 2 was

TABLE 1

Synthetic Organic Chemical	United States 1943 Production (Pounds)[1]	POSSIBLE PROCESSES AND RAW MATERIALS		
		Basic Hydrocarbon Raw Material	Intermediate Hydrocarbon Raw Material	Processes
Acetaldehyde	224,445,142[2]	Ethane Propane	Acetylene	Regenerative Cracking
Acetic Acid (100 percent)	264,898,632[2]	Ethane Propane	Acetaldehyde	Regenerative Cracking
Acetone[3]	336,000,000	Butane	Isopropyl Alcohol	Tubular or Regenerative Cracking
Acrylic Resins	25,000,000[4]	Butane	Ethylene Propylene	Tubular or Regenerative Cracking
Ethyl Alcohol	344,000,000[4]	Ethane Propane	Ethylene	Tubular or Regenerative Cracking
Formaldehyde (40 percent)	485,000,000	Methane	.....	Steam Conversion or Catalytic Oxidation
Methyl Alcohol	430,000,000[4]	Methane	Water Gas	Steam Conversion
Isopropyl Alcohol	380,000,000	Butane	Propylene	Tubular or Regenerative Cracking
Vinyl Resins[5]	100,000,000	Ethane Propane	Acetylene Ethylene	Regenerative Cracking

[1] Approximated by Chemical and Metallurgical Engineering (February 1943). [2] From U. S. Tariff Commission (1942 Production).
[3] It is assumed that the greater portion of acetone is derived from isopropyl alcohol as shown. [4] Estimated from basic data in Chemical and Metallurgical Engineering (February, 1943). [5] Includes Vinyldiene Chloride.

Material requirement: The total production of synthetic organic chemicals, by processes as shown, could be produced from the recoverable ethane, propane, butane fractions of 480 billion cubic feet of natural gas (about 75 percent of the 1941 gas lost or watsed) with the accompanying methane and heavier residue converted into approximately 44.4 million barrels of gasoline, diesel, heavy oil mixture via the Steam Conversion and Fischer Tropsch processes.

TABLE 2
(Alternate Method)

Synthetic Organic Chemical	United States 1943 Production (Pounds)[1]	POSSIBLE PROCESSES AND RAW MATERIALS		
		Basic Hydrocarbon Raw Material	Intermediate Hydrocarbon Raw Material	Processes
Acetaldehyde	224,445,142	Ethane Propane	.....	Oxidation
Acetic Acid (100 percent)	264,898,632	Ethane Propane	Acetaldehyde	Oxidation
Acetone	168,000,000	Ethane Propane	.....	Oxidation
Acetone	168,000,000	Butane	Propylene	Tubular or Regenerative Cracking
Acrylic Resins	25,000,000	Butane	Ethylene Propylene	Tubular or Regenerative Cracking
Ethyl Alcohol	344,000,000	Butane	Ethylene	Tubular or Regenerative Cracking
Formaldehyde (40 percent)	485,000,000	Ethane Propane	.....	Oxidation
Methyl Alcohol	268,500,000	Ethane Propane	.....	Oxidation
Methyl Alcohol	161,500,000	Methane	Water Gas	Steam Conversion
Vinyl Resins	100,000,000	Butane	Acetylene Ethylene	Tubular or Regenerative Cracking

[1] Refer to Table 1 for source of data.

Material Requirement: The total production of synthetic organic chemicals, by processes as shown, could be produced from the recoverable ethane, propane, Butane fractions of 630 billion cubic feet of natural gas (total gas lost or watsed, 1941) with the accompanying semi-dry gas converted into approximately 55.5 million barrels of gasoline, diesel, heavy oil mixture via the steam conversion and Fischer Tropsch processes.

achieved principally through use of ethane, propane and butane, or less than 20 percent by weight of the natural gas. Further, in view of the fact that ethane, propane and butane fractions are presently extracted from natural gas and are readily transportable by modern methods, this study loses its hypothetical character and assumes practical economic stature. It is, then, interesting to note that although dry natural gas (principally methane) is of importance as a chemical raw material, analysis of the extent situation suggests that the heavier available fractions be utilized. Such use will preserve for the natural-gas industry its source material—dry natural gas.

Additional dry natural gas will also be made available for conversion into liquid hydrocarbon fractions, chiefly the aforementioned mixture of gasoline, diesel oil and heavy oil. Pilot-plant operations are now getting under way, and it is altogether likely that in the near future natural gas will be a raw material in commercial-scale operations. A potentially enormous volume of natural gas could thereby be utilized in supplanting the anticipated early decline in productivity of crude oil. However, it is the authors' opinion that, although natural gas may be used in this capacity, its conversion to liquid hydrocarbons will take place in locations readily accessible to one or more fields but inaccessible to pipe-line outlets, and where gas was perhaps even being wasted. Petroleum reserves should continue to bear by far the greater part of the load through imports and new discoveries in the United States. When large-scale conversion is necessary, oil shale and coal may be expected to provide the principal raw material sources. Natural gas may play a part therein, but only on a secondary scale, since the huge quantities required for Fischer-Tropsch conversion may be prohibitive. Moreover, potentially greater yet less exhaustive needs exist for natural gas in its capacity as a chemical raw material.

Future of Natural Gas as a Chemical Raw Material

An analysis of the future of natural gas in this capacity as a chemical raw material has its background in the role assumed in World War II. Today large quantities enter into the production of carbon black, absolutely essential in the successful use of synthetic rubber, not only for tire-compounding, as was the case with natural rubber, but for all other uses. Appreciable quantities of natural gas derivatives are also used in the production of synthetic rubber. Still other quantities enter into the production of modern aviation fuel. Some 50 percent of the emergency synthetic ammonia is produced from hydrogen derived through the decomposition of natural gas by the steam conversion process. Further, an as yet small portion of the synthetic organic chemicals listed in Table 1 and 2 finds natural gas as the starting raw material. The present use of natural gas as a chemical raw material is in itself an amazing accomplishment, strongly indicative of postwar use.

It is evident from the foregoing that the chemical product derivatives of natural gas provide the public with a potential source of new and improved materials—materials with amazing industrial applications, developed through the gas chemist's molecular magic. What may be less obvious is that they also present the gas industry—particularly, but not necessarily exclusively, with a potential source of new revenue.

By and large, the gas industry has played a passive role in the attainment of experience relating to the new petro-chem developments, as well as in the technical research which that experience precludes. It is to be hoped that the establishment of the Institute of Gas Technology at Chicago typifies a dress rehearsal for a more active role—one in which Frank C. Smith, president of the Southern Gas Association, has been most aggressive in demanding. The important work of the Gas Institute must be continued, even expanded, under the gas industry's sponsorship. But this is only a start. Outposts should be established in colleges and universities throughout the country through grants set up by the gas industry.

From the foregoing it is evident that the natural-gas industry has unlimited possibilities in the postwar period and many years thereafter. Reserves guarantee many years of successful operations with heavier derivatives of natural gas becoming of increasing importance as chemical raw material in the ever-expanding petro-chem operations. Although dry natural gas is of importance as a chemical raw material, less exhaustive needs exist for it, with present trends suggesting that heavier fractions are more desirable for chemical processing. These conditions should preserve for the natural gas industry its source material—dry natural gas. Thus, a balanced market is being created to use the complete range of our gaseous hydrocarbons, assuring maximum hydrocarbon utilization with natural gas as a raw material.

Test Pressure and Safe Dimensions Of Welded Pressure Vessels

H. F. LASSNER

AS CAREFULLY as both the ASME and the API-ASME codes for welded pressure vessels have been prepared, naturally, it has not been possible to cover each and every detail of design and fabrication coming up in practice. One or the other passage in the code seems to allow for different interpretations and it is up to the good judgment of either the designer or the inspector of a vessel whether or not he considers certain details and dimensional data admissible or compatible with the code. Like any other laws, the code rulings are an excellent means for the establishment of order and public safety in their particular line. Like any law, however, they should not be applied in an automatical, stereotyped way, but they should be interpreted with a thoughtful understanding of the basic ideas upon which they had been established. A well meant, but all too verbal interpretation of the codes leads many designers to overdimensioning of some vessel parts that had not been intended by the "legislators" who prepared the codes. It is necessary to grasp the fundamental thoughts that led to the conception of design standards of this kind in order to arrive at a sensible understanding of certain paragraphs. Sensible, because it takes care of the safety angle as well as the economy in design which lies not only in the purchasers' interest but also in a public interest in our time.

A typical item of the mentioned sort, where considerable confusion exists, is the determination of the pressure for the hydrostatic test. Both codes define the test pressure as not less than 1.5 times the allowable working pressure. In paragraph U-64 of the ASME Code the relative rules say that the maximum allowable working pressure "used in determination of the test pressure shall be that at normal atmospheric temperature and based on the actual dimensions and plate thicknesses required for the pressure and temperature that are to be stamped on the vessel." The expression "actual thickness" usually is interpreted as the thickness of shell or heads as manufactured, thus including an eventual excess thickness used because the calculated value gets in between two standard plate thicknesses of which the greater is to be chosen. However, if the rest of the mentioned sentence is considered: ". . . required for the pressure and temperature that are to be stamped . . ."—it is rather doubtful if the above understanding applies. There is no reason against a conception that the dimensions and plate thicknesses required for the service conditions are just the ones resulting from the design calculations stipulated in the code, excluding any excess wall beyond that thickness. In that case the test pressure is only 1.5 times the design pressure.

The corresponding paragraph W-525 of the API-ASME Code is quite differently worded. "The test pressure shall be determined by the allowable working pressure of the weakest part of the vessel as computed from the formulae and methods of design required by this Code (assuming corrosion allowance "c" to be zero, and the maximum allowable working stress "s" to be that permitted at test temperature) and also from other loadings which may exist during the test." That indicates that the a.w.p. is to be figured back from the sum of the thickness required for the design pressure plus eventual other loads, plus the thickness added for corrosion.

Although the expression "actual thickness" is not used here as in the ASME Code, it has become standard practice to base the a.w.p. on the full thickness "when new", including corrosion allowance and an eventual excess wall that often occurs due to the mentioned or other conditions. The idea is to stress the material in a linear proportion higher as it is thicker, so that after corrosive thinning the wall will still safely stand the design pressure.

Flat Cover Design

It is evident that any excess wall makes the vessel, after corrosion has acted, stronger than it is required by the strength computation, thereby making for a higher factor of safety. Somewhat different is a condition, when f.i. a large horizontal storage tank has to stand localized stresses at the locations of its supports. Then, by structural reasons, the vessel wall must be chosen much heavier than the relatively low internal pressure would require and the a.w.p. "when new" is by far higher than the internal design pressure.

A flat manhole cover is to be figured as outlined in paragraph W-316 of the API-ASME Code. This paragraph is not entirely outspoken as to what value should be used as a.w.p. for the determination of the cover thickness. A rather important footnote to paragraph W-525 indicates that during the first hydrostatic test the longitudinal joint of a vessel should be given a minimum stress equal 1½ times the a.w.p. related to its thickness. This procedure is not mandatory, but whenever the longitudinal weld is not stressed that high at the test after completed fabrication, the code prescribes periodic pressure tests to be conducted after the vessel has been taken into service—a rather undesirable proposition for the user of a vessel. In other words, if any part of a tank other than the longitudinal seam becomes its weakest part, thus determining the admissible test pressure, periodical pressure tests have to be given during its service.

Quite often a manhole cover thick enough to stand the internal design pressure may become the weakest part, if a vessel's wall, for reasons of rigidity, contains the mentioned excess thickness. In such a case most designers will increase the manhole-cover thickness to a value based on the a.w.p. related to the heavy vessel wall, thus rendering to its longitudinal seam its function as "limiting part" for the pressure during the test. As laudable as such strict adherence to the code rules may be, it appears not entirely justified from a practical angle.

To illustrate these conditions, a typical example will be given. A horizontal storage tank has 10 feet mean diameter, 40 feet length, design pressure (internal) of 30 psi., no corrosion allowance required. The tank has a 16-inch series 15 standard manhole. Material to be ASTM spec. A70 flange quality steel, no radiographing, no stress relieving (joint efficiency E=0.78).

According to $T=\frac{pDm}{2sE}$ vessel wall thicknesses are shown proportional to maximum a.w.p. in Figure 1, line "a."

According par. W-316 manhole covers are figured as follows: $H=\frac{d^2\pi}{4}\times p$; $C=0.3+\frac{1.4\,Wh_G}{Hd}$; $t=d\sqrt{\frac{Cp}{s}}$

$W=16\times 0.694\times 11000=122{,}000$ lbs.

Standard dimensions for a 16-inch Series 15 cover are shown in Figure 2. Cover thicknesses are plotted against a.w.p. in Figure 1, line b. From the smaller slope of this line it may be seen that the cover thickness grows much slower with increasing pressure than the vessel wall does.

For an internal pressure of 30 psi the cover thickness is figured to 1.335 and this dimension is rounded up to 1⅜-inch thick plate. The figured value for the vessel wall, when 30 psi internal pressure is applied T = 0.17 inch. To meet concentrated stresses at the supports a shell thickness T=¾ inch is chosen instead of the theoretical value of 0.17 (the procedure in determining the reinforcement required at the supports goes beyond the scope of this paper). Figuring back from T=¾-inch, an a.w.p. of 134 psi is found, resulting in a test pressure of

$$p_{test}=1.5\times 134=201 \text{ psi.}$$

Checking a 1.375 in. cover against this test pressure

$$H=\frac{18.5^2\pi}{4}\times 201=54{,}000 \text{ psi;}\quad C=0.3+\frac{1.4\times 122{,}000\times 2}{54{,}000\times 17.25}=0.3+0.366=0.666$$

$$S=\frac{d^2}{t^2}C\times p=\left(\frac{17.25}{1.375}\right)^2\times 0.666\times 201=21{,}000 \text{ psi.}$$

it is found that the resulting stress in the cover during the hydrostatic test (21,000 psi.) is by far lower than the yield point of the material and its temporary application while testing appears absolutely safe, although the test pressure amounts to almost 7 times the value for which the cover has been designed.

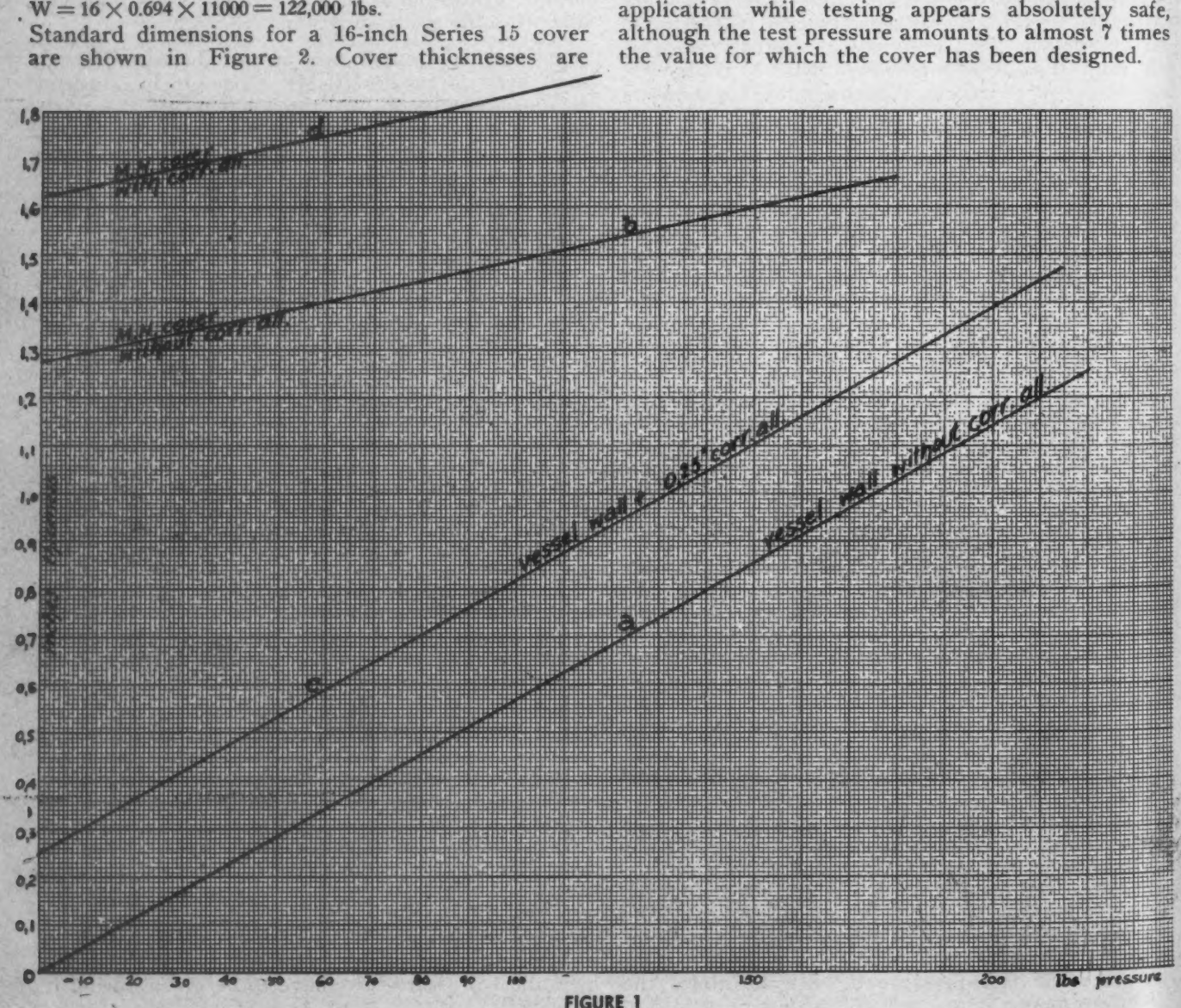


FIGURE 1

A similar condition exists in all cases where corrosion allowance has to be added. The corresponding lines are shown in Figure 1 as lines c and d, for ¼-inch c.a. The additional thickness put in the cover will largely allow for the increased a.w.p. in a shell wall that contains corrosion allowance. In this case a cover designed for internal pressure will carry still lower stresses during the hydrostatic test than the cover in above example, all the other conditions being the same.

In figuring the thickness of a flat cover plate it had been usual to apply this working stress times the number of bolts and the area based on the mentioned standard diameter of the bolts in order to find the total bolt load in pounds. The resulting W becomes exceedingly high, by far higher than necessary to stand the actual operating conditions. Using the formulae mentioned before, the computed value of the cover thickness exceeds considerably what may be called appropriate from a viewpoint of safety and economy. It is easy to be seen that such

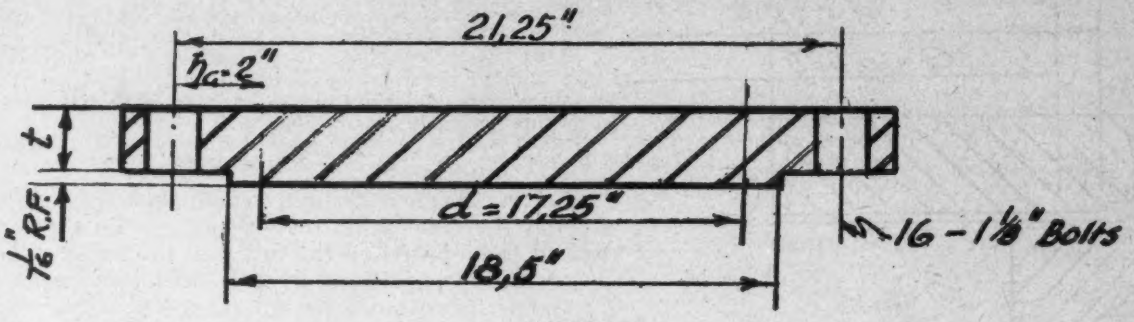


FIGURE 2

Taking similar views as in designing manhole covers some designers are inclined to figure reinforcing pads for shell openings on the basis of an a.w.p. derived from a shell made extra strong to stand wind load, impact loads or the mentioned localized stress. The resulting reinforcement rings are often by far too heavy, quite out of proportion with the actual operating pressure of the vessel. Also here a sensible interpretation of the code may help to avoid waste of material and labor. Whenever a shell, for structural reasons, is to be made heavier than required for internal pressure, it appears unnecessary to design shell openings for an a.w.p. derived from the combined stresses in the shell. These details are not subject to the additional structural stresses, they should, consequently, be dimensioned to the internal design pressure only.

A Suggestion Regarding the Bolt Load

Under point f of par. W-317 of the API-ASME Code the total bolt load "W" determining the thickness of a cover plate is defined as the product of A_B, the total cross sectional area of the bolts taken at the root of the thread, times S_B, the maximum allowable unit working stress in the bolt. It is common practice to use the standard number and diameters of bolts and studs as given by Taylor Forge & Pipe Company and other companies in their catalogs for forged flanges of all kind. These bolt diameters, however, have obviously been figured for carbon steel bolts, admissible up to 450° F. operating temperature and allowing 11,000 psi. as design working stress according to point "e(1)" of the cited paragraph.

Whenever the operating temperature exceeds 450 degrees and or the pressure exceeds 160 psi. (Par. W-205a) alloy steel bolting material to ASTM Specification A96 is to be used. For this material, combining a higher tensile strength with a lower creeping rate, a tensile strength of 100,000 psi at normal temperature is specified in revised paragraph 317 e(2) of the API-ASME Code. Assuming a safety factor of 5 for bolts (higher than the S.F.=4 generally applied in the API-ASME Code) the design working stress for such bolts is S_B=20,000 psi.

(*) Modern Flange Design, 2nd edition, 1941, Bulletin No. 421.

a design procedure, as really applied on a large scale on hundreds of vessels, resulted in waste of materials and labor, highly undesirable under the strain of war time.

Accepting methods proposed by the Taylor Forge & Pipe Works* in 1942, both the ASME and the API-ASME code committees issued new rules in their 1942 addenda to the codes, covering the bolt load to be used in flange design. As a compromise, the arithmetic mean of the relative bolt pulls based on the computed minimum bolt area and the actually used bolt area becomes the criterion determining flange and cover thicknesses.

If standard bolt diameters are used—and that is advisable by practical reasons of standardization—it is not clear why the use of alloy bolts instead of carbon-steel bolts under otherwise equal conditions should result in proportionately higher stresses in the flanges. In both cases the bolt load applied to obtain a reliably tight joint appears to be the same. As a logical consequence, the required flange dimensions should be the same. It will appear that the discrepancy originates in the formulation of W-317 points e and f, which stipulate that S_B be the maximum allowable working stress of the bolting material used.

It appears logical and safe to design the flange and cover for a bolt load based on carbon-steel bolts, even when alloy-steel bolts are used. Similarly as expressed in par. W-317 e(2) the stress allowed at temperatures over 450° F. could be determined by applying the reduction factors for forged steel, given in the chart Figure 1 of the code, to a tensile strength of 55,000 psi. of ASTM Spec. A-107 carbon steel bolts. The additional strength inherent in alloy-steel bolts at normal and elevated temperatures will furnish a safety factor much higher than 4, thereby taking care of an eventual abuse occurring in tightening the bolts.

An example will serve to clarify the above suggestions. As the flange computation is rather involved, only the blind cover is considered in this example. However, the conclusions drawn apply equally to the flange proper.

Welded pressure vessel, $D_m = 60''$
design pressure $p = 250$ psi
design temperature = 750° F.
corrosion allowance $c = \frac{1}{4}$-inch

plate material to A.S.T.M. spec. A 70 flange quality; vessel to be radiographed and stress relieved. A 16-inch Series 30 manhole to be used, fabricated from the same plate material as the vessel.

Data for Manhole (see Figure 3):

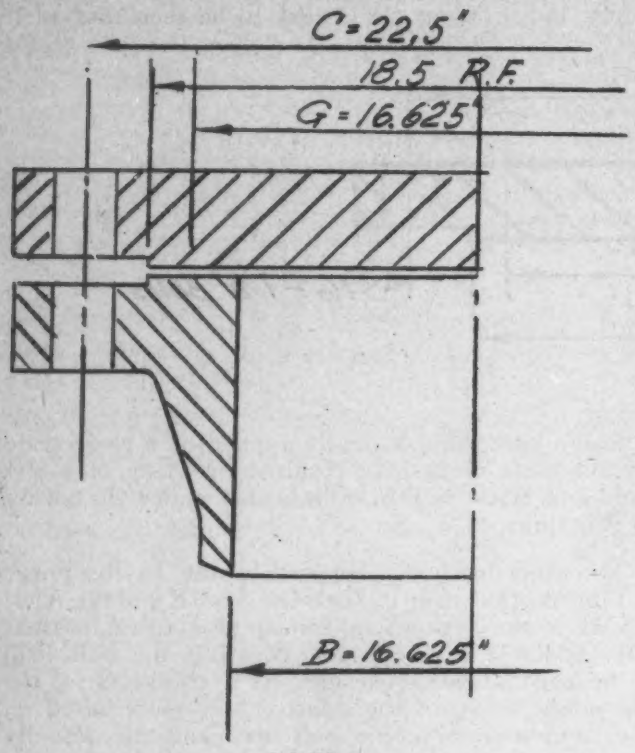


FIGURE 3

$G = 18.5''$; $B = 14.75''$; $d = \frac{18.5 + 14.75}{2} = 16.625$; $h_g = 2.938$

20 studs $1\frac{1}{4}''$ (according to standard flange tables);
$b = .5$; $y = 4500$; $m = 2.5$

Temperature factor 0.21

Allowable stress for **carbon steel bolts**: $s = 6875$ psi (see ASME Boiler Code revision 1941)

Minimum operating bolt load: $W_m = H + H_{gp}$

$$W_m = \frac{\pi G^2 p}{4} + 2b\pi Gmp = \left(\frac{\pi}{4} \times 18.5^2 \times 250\right) + (2 \times 0.5 \times \pi \times 18.5 \times 2.5 \times 250) = 36300 + 67100 = 103{,}400 \text{ lbs.}$$

Actual bolt load:

$$W_{act} = 20 \times 0.893 \times 6875 \times \frac{21}{25} = 103{,}100 \text{ lbs.}$$

(in this case W_{act} is about equal W_m; design thus based on W_m)

$$C = 0.3 + \frac{1.4 \times 103400 \times 2.938}{67100 \times 16.625} = 0.3 + 0.38 = 0.68$$

$$t = 16.625 \sqrt{\frac{0.68 \times 250}{55000 \times 0.21}} = 2.02, \text{ take } 2''$$

Usual design for alloy steel bolts

W_m as above

$$W_{act} = 20 \times 0.893 \times 16000 \times \frac{21}{25} = 240{,}000 \text{ lbs.}$$

$$W = \frac{W_m + W_{act}}{2} = \frac{103100 + 240000}{2} = 171550 \text{ lbs.}$$

$$C = 0.3 + \frac{1.4 \times 171550 \times 2.938}{67100 \times 16.625} = 0.3 + 0.631 = 0.931$$

$$t = 16.625 \sqrt{\frac{0.931 \times 250}{55000 \times 0.21}} = 2.366$$

The next standard gauge for plate is $2\frac{1}{2}''$; consequently a 25% thicker cover is to be used than necessary when the design was based on carbon steel bolts, showing clearly the advantage in the proposed design procedure obtained without abandoning the principle to have a tight joint and a sufficiently strong cover.

Summary

It has been attempted in this paper to demonstrate that the conception of both codes, the test pressure had to be based on the full wall thickness of a vessel containing additions over a thickness necessary to stand the internal design pressure, leads many designers to "overdimensioning" parts of shell openings. This is particularly true with regard to the API-ASME Code ruling that the longitudinal weld of a vessel be given the full test pressure proportional to its thickness after completed construction. It is emphasized that thickening such parts as manhole covers and reinforcing pads just to let them match a temporarily applied test pressure appears as an unnecessary expenditure, particularly when the stress in the engaged parts remains under the yield point of the material. Further, it is questioned if the application of alloy bolts justifies the use of a higher value for the bolt load applied to achieve a tight joint, than that resulting when carbon-steel bolts were used instead. The practice of applying such a higher bolt load in the design seems to increase flange and cover thickness beyond values commensurate with safety and appears, therefore, uneconomical. In the interest of conserving material and labor these questions are brought to the attention of the interested parties, especially so to the API-ASME committee on unfired pressure vessels and to the insurance companies in charge of inspections.

This article is a repetition, with additions and corrections, of the identical subject as printed in the December, 1943, issue of *Petroleum Refiner*, 22, 12, pp. 89-92. Because of miscarriage of mail, the author did not make corrections in proof, with the result that repetition of the article was necessary. Since it was being repeated, some later code developments were added and another illustration, Figure 3, used.

For all indexing this article should be used and the same subject in December ignored.

Application of Unit Operations To Fractionation and Other Vaporization Processes

3. A Study of Hydrocarbon Mixtures

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ADOPTION of this series of articles as the basis for study, especially in vocational classes, is one of the possible uses for this fundamental data on condensation and fractionation. Study within refining personnel may be based on the articles.

In a previous series in 1941 several instances of these uses came about.

The author stressed the point in his first article, however, that the study of the papers will not take the place of class-room instruction in engineering.

He does feel, from his own experience in plants, that the articles will give the engineer and the plant operator an understanding of the physical laws governing the behavior of hydrocarbons and the quantitative method of attack in solving engineering problems pertaining to certain unit processes, in particular, vaporization.

AS A RULE liquid hydrocarbons are miscible in each other in all proportions, hence their behavior is somewhat different from that of immiscible or partially miscible liquids. Each component in the liquid mixture, instead of exerting its full vapor pressure, has a partial pressure effect equal to the product of its vapor pressure by the mol fraction of the same component. The behavior of these hydrocarbon mixtures might be compared to that of a team of horses; the spirited horse would tend to speed up the slower moving member of the team while the slower horse would tend to slow down the more highly spirited one. In the same way with a mixture of butane and pentane, the butane would help to vaporize the pentane while the pentane would tend to hold back the butane from vaporizing so readily. This law is known as Raoult's and is a special case of Henry's law.

Mathematically these laws can be expressed as follows:

(1) Raoult's law (expressing the equilibrium relationship between vapor and liquid.)

$$\pi y = px$$

Where π = Total pressure on the system
y = Mol fraction of any component in the vapor
p = Vapor pressure of the same component in the pure state
x = Mol fraction of the same component in the liquid.

The partial pressure of any component in the vapor is the product (πy) and the partial pressure of the same component in the liquid is (px).

(2) Henry's law

$$y = Kx$$

Where y = Mol fraction of any component in the vapor
K = Proportionality or equilibrium coefficient
x = Mol fraction of the same component in the liquid

This law is more general in scope than Raoult's since it satisfies all conditions, the value of K being determined experimentally. In the absence of K values, Raoult's law does provide a convenient tool for making calculations in certain ranges of pressure, temperature and solubility relationships.

P-V-T Relationships of a Hydrocarbon

One of the most common methods of presenting the phase relationships of vapors and liquids is to plot isotherms (constant temperature lines) on the pressure-volume planes. Unless such a graph can be seen in three dimensions (P-V-T), a true picture of

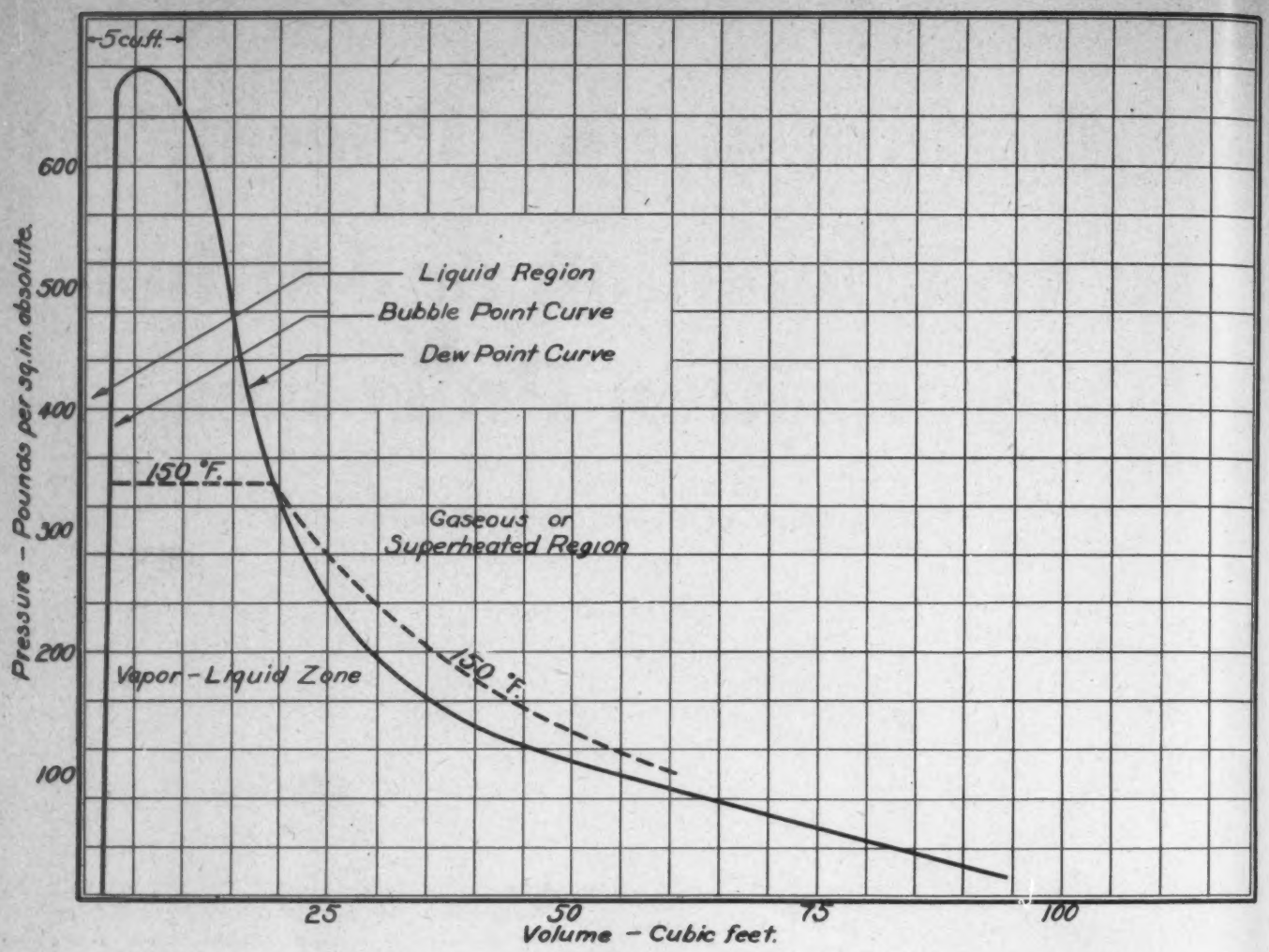

FIGURE 1

P-V-T Propane Diagram Basis—One lb. mol of propane. Approximate volumes are shown

these relationships cannot be clearly obtained, hence the importance of making solid scale models. It is well to remember that each isotherm is in a different (P-V) plane.

Propane

The pressure-volume-temperature relationships for propane are shown on a semi-quantitative scale in Figure 1. By taking a pound mol of propane as a gas and compressing it isothermally from a low pressure at 150° F., the hydrocarbon is found to follow approximately the perfect gas law until it reaches the dew point curve, the boundary between the gaseous and the vapor-liquid regions. From this point condensation takes place at a constant pressure of 340 pounds per square inch absolute and 150° F. until all the propane is condensed as liquid. Further compression at 150° F. causes a very slight reduction in volume due to the small compressibility of liquid propane.

Propane—Normal Butane System

In Figure 2, a P-V-T diagram is given for the above binary mixture of hydrocarbons. There is a marked similarity in the general shape of the vapor-liquid dome as well as the isotherms with the exception of the path across the vapor-liquid region.

(a) Dew Point Calculation

When this mixture is compressed at 100° F., the first drop of liquid which condenses is not pure butane, although the liquid droplet is richer in butane than the vapor from which it is condensed. If the vapor consists of a 50-50 molal mixture of propane and normal butane, the composition of the first drop and the pressure can be calculated for the 100° F. isotherm by setting up an equilibrium equation for each component.

Partial Pr. in Vapor = Partial Pr. in Liquid

Total Pr. × mol frac in vapor = vap. pr. × mol frac in liquid, or by conventional symbols

$$\pi y = p x$$

(1) (Propane) $\pi\ 0.5 = 188\ x_3$

(2) (N Butane) $\pi\ 0.5 = 55\ x_4$

(3) $x_3 + x_4 = 1$ or $x_4 = 1 - x_3$

Substituting in Equation (2)

(4) N Butane π $0.5 = 55(1 - x_3)$

(5) Subtracting (4) from (1) $0 = -55 + 243x_3$

$X_3 = 55/243 = .226$ mol fraction of propane in first drop

Substituting in (3) $x_4 = .774$ mol fraction of N butane in first drop

Substituting in (1) $\pi = \frac{188\ (.226)}{0.5} = 85$ lbs./sq.in. Total pressure required for initial condensation.

(b) Bubble Point or Total Condensation

Unlike the single hydrocarbon, the mixture will require a higher pressure to bring about complete condensation. The calculation of this pressure and the composition of the bubble of vapor in equilibrium

with the condensate is carried out in the same manner as in the case of the dew point.

	$\pi y = p x$
(1) Propane	$\pi y_3 = 188\ (.5)$
(2) N Butane	$\pi y_4 = 55\ (.5)$
(3) N Butane $\pi(1-y_3)$	$= 55\ (.5)$
(4) Adding (3) and (1)	$\pi = 94 + 27.5 = 121.5$ lbs/sq. in. Total pressure

$y_3 = \frac{188\ (.5)}{121.5} = .733$ mol fraction of propane in vapor bubble

$y_4 = 1 - y_3 = .227$ mol fraction of N Butane in vapor bubble

(c) Partial Condensation at 103.25 Pounds Pressure (approximately midway between dew point and bubble point).

	$\pi\ y = p\ x$
(1) Propane	$103.25\ y_3 = 188\ x_3$
(2) N Butane	$103.25\ y_4 = 55\ x_4$
(3) N Butane $103.25(1-y_3)$	$= 55(1-x_3)$

Adding each side of 1st and 3rd equations

$$103.25 = 55 + 133x_3$$

$x_3 = .363$
$x_4 = .637$ } Composition of Condensate

$y_3 = .66$
$y_4 = .34$ } Composition of Vapor

A material balance can be made, Figure 3, in order to determine the fraction of the mixture which is vaporized at 103.25 pounds and 100° F.

The balance for propane, on the basis of 1 mol of mixture fed to the separator, is

	Input		Vapor	Liquid
Propane	(1) (.5)	=	V.66	+ (1 — V) (.363)
Butane	1 (.5)	=	V.34	+ (1 — V) (.637)
		V =	.462	1 — V = .538

Mols propane liquid $= .538 \times .363 = .195$
Mols N Butane liquid $= .538 \times .637 = .343$
$.538$

Volume of .462 mols of vapor at 103.25 lbs. and 100° F.

lbs. mols		Std. Cu. Ft. / Mol		Pr. Correction		Temp. Correction	
.462	×	380	×	14.7 / 103.25	×	560 / 520	= 26.9 cu. ft.

Volume of the liquid mixture in condensate

Propane $\frac{.195 \times 44}{62.4 \times .515} = .268$ cu. ft. of liquid

Butane $\frac{.343 \times 58}{62.4 \times .582} = .546$ cu. ft. of liquid

$.814$ total cu. ft. of liquid

Total volume liquid and vapor = 27.714 cu. ft.

The following review exercises are suggested for those readers who wish to gain a working knowledge of the principles discussed in this series of papers. The solutions to these exercises will appear in next month's issue.

(1) A vapor mixture consisting of 60 mol-percent

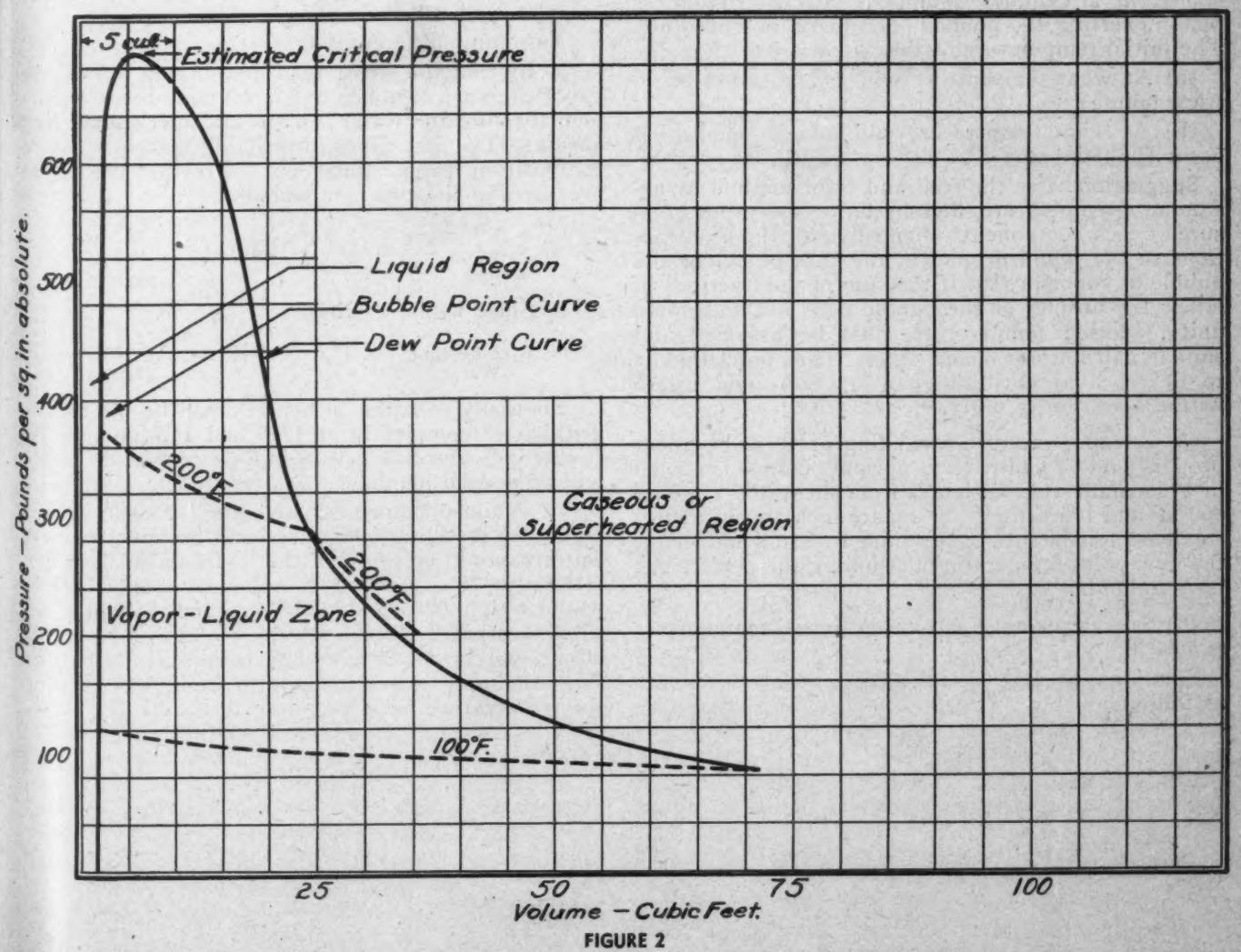

FIGURE 2

P-V-T Propane-N Butane Diagram Basis, one lb. mol of mixture (50-50) molal percentages. Approximate volumes are shown.

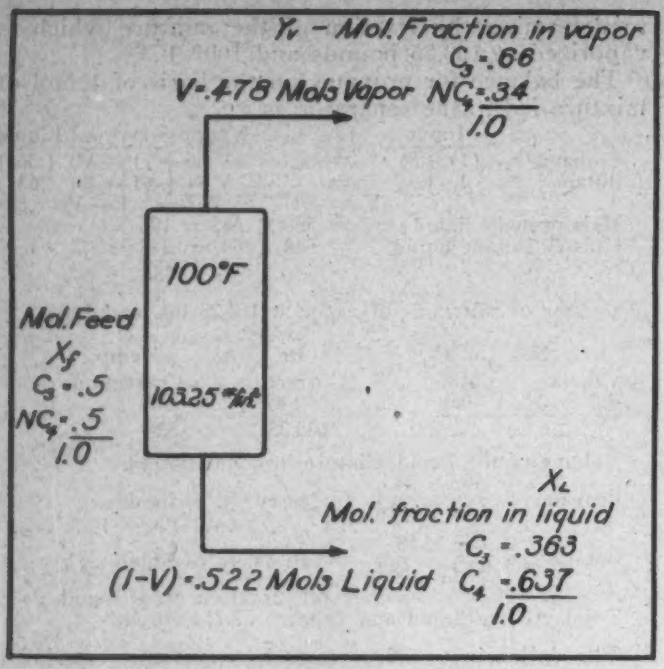

FIGURE 3

Partial Vaporization of 50-50 Propane-N Butane Mixture at 100° F. and 103.25 lb. pressure.

normal butane and 40 mol-percent normal pentane is cooled in a cylinder equipped with a frictionless piston exerting 100 pounds per square inch absolute. The initial temperature of the vapor is 300° F.

(a) At what temperature will condensation begin (dew point)?

(b) At what temperature will total condensation occur (bubble point)?

Suggestion: Use the trial and error method by assuming a temperature, thereby fixing the vapor pressure of each component. Then solve for the mol fractions in the liquid droplet in the case of (a) or the bubble of vapor in (b). If the sum of the fractions in either the droplet or the bubble does not add up to unity, another temperature must be assumed and similar calculations made again. This procedure is to be repeated until the mol fractions add up to within 1 percent of unity.

(2) A vapor mixture consisting of 40 mol-percent propane and 60 mol-percent normal pentane is cooled in a constant volume bomb from an initial state of 300° F and 100 pounds per square inch absolute until condensation begins. Determine by trial and error, the dew-point temperature, assuming the perfect gas laws to hold.

(3) Same as exercise (2) except initial temperature is 500° F.

Solutions to last month's review exercises are as follows:

(1) In what volume ratio would normal hexane and water have to be present, both in the vapor state at 100° F., in order that the two components would condense simultaneously and at what absolute pressure would this condensation take place?

Since normal heptane and water are immiscible as liquids, each component will exert its full vapor pressure as a liquid regardless of the presence of the other component. Since the partial pressure of each component in the vapor must equal the vapor pressure of the same component in the liquid whenever such liquid is present, the vapor volumes will be proportional to the respective vapor pressure. At 100° F. normal heptane has a vapor pressure of 1.35 pounds per square inch absolute, and water, 0.95 pounds per square inch, the volumes will be

	vols.	vol%
n hexane	1.35	58.7
Water vapor	.95	41.3
	2.30	100.0

(2) Five pounds each of H_2O and n heptane are distilled at a constant pressure of 14.7 pounds per square inch absolute.

(a) At what temperature will the first vapor be evolved? What will be its mol composition?

(b) Which component will be the first to distill over completely and at what temperature?

(c) How many pounds of the other component will be left in the still at the time the first component is completely distilled overhead?

(Assuming different temperatures.)

(a) By trial and error, it is found that at 175° F. the vapor pressure of n. heptane is 7.9 pounds per square inch absolute and water is 6.8 pounds per square inch absolute. The first vapor formed will therefore have a composition proportional to the respective vapor pressures of the two components or

		mol%
n heptane	7.9	53.7
water	6.8	46.3
	14.7	100.0

(b) Since we have initially:

		lbs.	lbs. mols
n heptane	C_7H_{16}	5	5/114 = .0437
Water	H_2O	5	5/18 = .2780

It is easily seen that n heptane will be the first to distill over completely at 175° and 14.7 pounds per square inch absolute as 53.7 mol-percent of the vapor will be normal heptane.

(c) While 5 pounds of heptane (or .0437 pound mols) are distilling over there will be fewer mols of water vapor coming off of the liquid, or 46.3/53.7 × .0437 = .0375 pound mols of water vapor, which would weigh .0375 × 18 = .677 pounds of water distilled overhead. Therefore, the water remaining as liquid will be 5-0.677 = 4.323 pounds. In order for this remaining water to distill over at 14.7 pounds, the temperature must be raised to 212° F.

Connections must be kept tight at all times.

Loose connections are a frequent but very elusive cause of operating troubles.

Refinery Operation Demands Effective Maintenance Of Motor Starters

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and
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SATISFACTORY maintenance of electrical equipment requires competent men and a thorough and adequate plan of handling the inspection and repair work. Good inspection and prompt repairs will avoid high maintenance costs; complete replacements will often be avoided; down time will be kept at a minimum.

In the operation of petroleum refineries conditions governing the maintenance of electrical apparatus are about as difficult as can be found in any field of industry.

First, the equipment usually must operate under a tough combination of physical conditions including prevalence of corrosive elements, occurrence of or liability to explosion-hazardous atmosphere conditions in various degrees of severity, location frequently outdoors, and in many cases at coastal sites involving salt air and extreme humidity. To stand up in refinery service, apparatus must be built for these conditions.

Next, the character of most refinery operations is such as to impose special limitation upon the establishment of schedules for inspection and maintenance. From this standpoint there are really two types of operation. First are the overall utility and service activities, for which maintenance schedules can be established in much the same way as for ordinary industrial and central-station requirements. However, the bulk of the motor-control equipment in a refinery is functionally grouped, along with other inter-dependent apparatus, into one or another specific process unit. When such unit goes on stream it is expected to run continuously day and night for many weeks without shutdown, until operation is suspended for process reasons. During the run it is naturally essential that each component part of the unit function continuously and reliably. It is true that duplicate standby equipment is provided for contingent operation of the most critical drives. Also unscheduled interruptions may occur, but these are held to the minimum in number and duration. By and large, during the run it is necessary to limit inspection and maintenance to such operations as can be performed without removing the control from

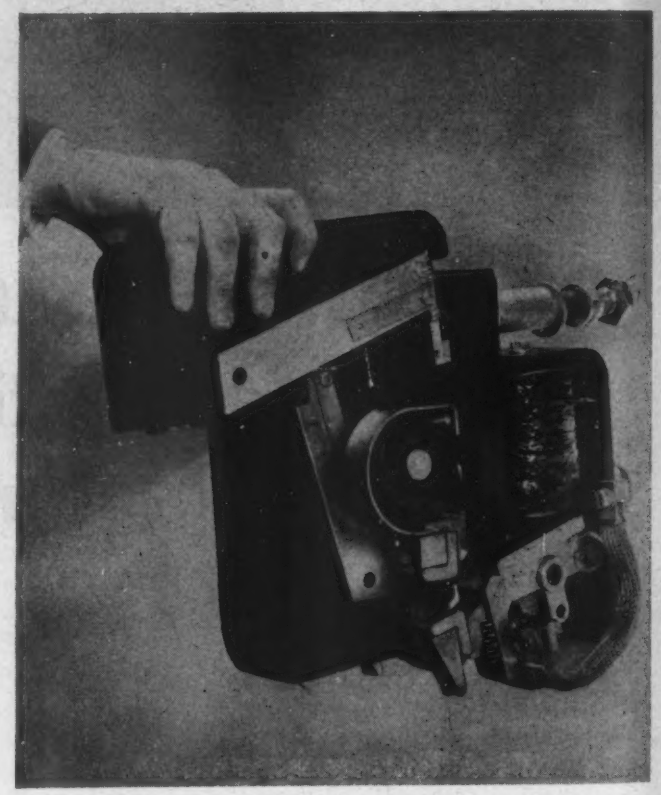
Check Chart for Motor-Starter Trouble

	CAUSE	WHAT TO DO
Contactor or relay does not Close	No supply voltage	Check fuses and disconnect switch.
	Low voltage.	Check power supply. Wire size may be too small.
	Open circuited coil.	Replace.
	Push button contacts not making.	Clean and replace if badly worn
	Interlock or relay contact not making.	Adjust and replace if badly worn.
	Loose connection or broken wire.	Check circuit with "flash light" (turn off power first!)
	Overload relay contact open.	Reset.
Contactor or relay does not open	Push button not connected correctly.	Check connections with wiring diagram.
	Shim in magnetic circuit * worn allowing residual magnetism to hold armature closed.	Replace.
	Interlock or relay contact not opening circuit.	Adjust contact travel.
	"Sneak" circuit.	Check control wiring for insulation failure.
	Contacts well shut.	See "Contacts Weld Shut".
Contacts weld shut	Insufficient contact spring pressure causing contacts to burn and draw arc on closing.	Adjust, increasing pressure Replace if necessary.
	Rough contact surface causing current to be carried by too small an area.	Smooth surface and replace if badly worn.
Arc lingers across contacts	If blow out is serious, it may be shorted. If blow out is shunt, it may be open circuited.	Look at wiring diagram and see kind of blow out. Check to see if circuit through blow out is all right.
	If used, arc box might be left off or not in correct place.	See that arc box is on contactor as it should be.
	If no blow out used, note travel of contacts.	Increasing travel of contacts will increase rupturing capacity.
Noisy A-C Magnet	Improper seating of the armature.	Adjust.
	Broken shading coil.	Replace.
Excessive Corrosion of contacts	Chattering of contacts as a result of vibrations outside of the control cabinet.	Check control pressure and replace spring if it does not give rated pressure. If this does not help, move control so that vibrations are decreased.
	High contact resistance because of insufficient contact spring pressure.	Replace contact spring.
Abnormally short coil life.	High voltage.	Check supply voltage and rating of controller.
	Gap in magnetic circuit †.	Check travel of armature. Adjust so that magnetic circuit is completed.
	Too high on ambient temperature.	Check rating of contact. Get coil of higher ambient rating from manufacturer if necessary.
Panel and apparatus burned by heat from starting resistor	Motor being started too frequently.	Use resistor of higher rating.

* D-C only. † A-C only.

service. To meet these requirements, motor controls along with all other equipment are placed in prime condition before the unit is started, and in general any maintenance work involving stoppage of the unit is "out" for the duration of the run. At the end of the run, while the process apparatus is being reconditioned, opportunity is given for thoroughly inspection and for the performance of such maintenance work as may be necessary to put the equipment into first-class condition for another run. Such maintenance may include repairs or replacements of parts before complete utilization of their normal life, as insurance for operating continuity during the run.

These conditions are far from ideal from the standpoint of usual motor-control-maintenance practices, but they must be dealt with as a part of the overall economy of operation. Obviously they place a special importance upon ability of control apparatus to operate over long periods with minimum of maintenance, and naturally refinery control has evolved in this direction.



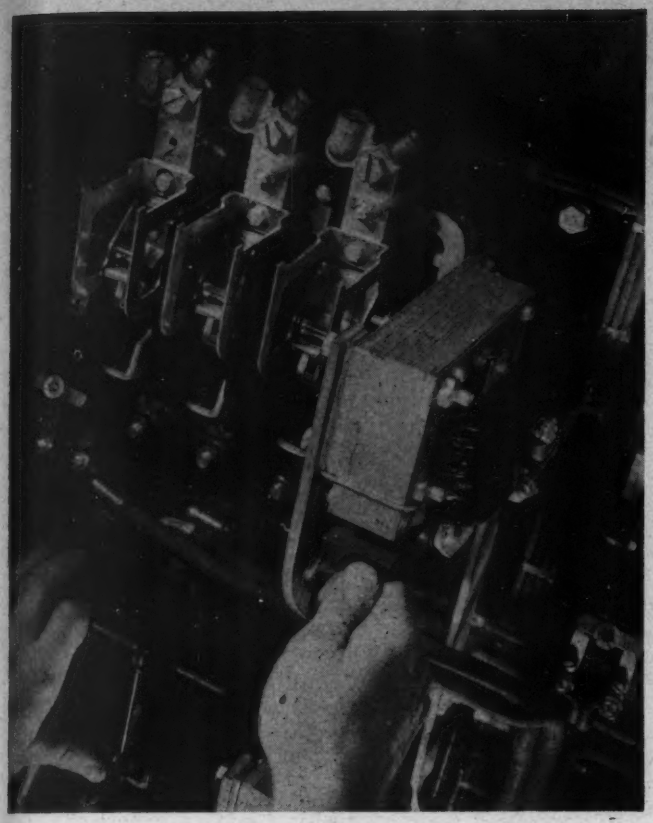
Close-up of d-c contactor.

Preventive maintenance begins with the proper selection of the motor starter. If it is not suitable for the installation or if it has insufficient capacity, maintenance troubles are inevitable.

Check Control at Regular Intervals

The initial inspection of a new installation should be thorough and operation observed at load conditions before final acceptance is made. After initial operation has been proved satisfactory, time schedules for routine inspection should be established to meet the service requirements. As motors and their starters are always associated, a combined schedule can require inspection of both. Monthly routine inspections as extensive as process operations will permit will do much to prevent troubles.

A well-organized plan of careful maintenance will prevent expensive repairs and extend the time pe-



Moving parts of contactors and relays must move freely and without evidence of undue friction. Bearings are made for severe duty and should not be oiled or greased.

riods between complete overhauls or replacements. Where shutdowns cannot be scheduled solely for maintenance work on electrical equipment, advantage should be taken of any shutdowns that may be occasioned for other reasons.

Oil and grease should never be applied to the bearings of an air-insulated contactor or relay. Experience has indicated that oil or grease will cause dirt to accumulate and eventually result in a sticky, gummy accumulation that causes sluggish action. The bearings are designed with these requirements in mind and no lubrication is required on any part.

Bearing parts should permit contactors or relays to operate freely and without apparent friction. If parts are out of alignment and excessive friction does exist, it should be eliminated. Sluggish action will cause electrical troubles.

No bearings are required when the moving parts of a contactor or relay are relatively light and the magnetic forces can be made strong enough to lift the movable parts vertically to close the contacts. This is an ideal design as far as beings are concerned. However, the moving parts must be guided within the solenoid and non-magnetic guides must be used to prevent magnetic sticking and sluggish action.

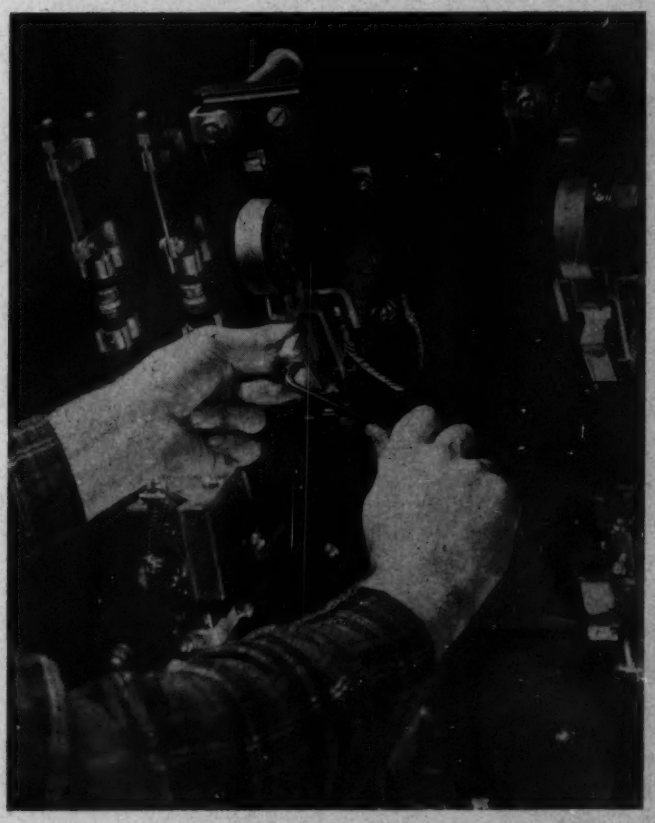
Although contacts generally are thought to be subjected primarily to electrical duty the mechanical duty is equally important. For this reason the manufacturer conducts endurance tests with no current through the contacts to observe how well they withstand the pounding, rolling and sliding or scrubbing action that occurs every time the contacts close. Contactor designs often provide a rolling action of the contacts so that the circuit is closed and opened on the contact tips instead of on the closed contact position.

When high currents that are difficult to interrupt are expected, powerful arc rupturing structures are supplied, in air-insulated starters and in high-voltage oil-immersed starters, to force the arc off the contacts and quickly extinguish it. These arc-rupturing structures are called arc boxes or blow-out structures. When in operating position they completely surround the contacts and must always be in correct position to rupture the arcs effectively. They are easily removed for inspection or replacement of contacts. They must be returned to proper position after inspection, otherwise the arc will not be properly broken and the contacts will be unnecessarily worn and burned.

Contacts should be renewed when badly burned or pitted and when worn thin. They should be clean but need not be smooth. In fact, a clean contact with a roughened surface comparable to coarse sandpaper is in very satisfactory condition and provides as good, or better, contact surface than perfectly smooth surfaces. If a contact surface is pitted or burned and not worn thin it can be cleaned and used again.

The method of cleaning is important. Coarse and crude filing wastes contact material, and is frequently done without sufficient care to maintain the original contact shape. The contact surfaces then have high spots and point contacts that are apt to overheat. Instead of filing, clean with sandpaper or by buffing wheel. A fine file is permissible if the contact shape is maintained. Emery paper should never be used as particles may adhere to the surface and cause unnecessary wear.

Silver contacts seldom require cleaning. They may look black and dirty because of the silver oxide but



Contacts worn through by long use or badly burned contacts must be renewed. Surfaces against which contacts are bolted should be cleaned. Clean copper contacts, though slightly roughened are entirely satisfactory. Silver contacts, though black in appearance, need not be cleaned. Be sure contacts are tight at all times.

Defective coils must be replaced. Designs are usually made so that coils may be changed easily and without much delay.

as the oxide is a conductor, cleaning is not often necessary.

When contacts are replaced, the surface against which they are bolted should be thoroughly cleaned. This is usually a current-carrying joint and a clean contact bolted to a dirty surface can not give best results. Both surfaces should be clean. Any traces of copper oxide should be removed.

The screws or bolts that hold contacts in place must be tight at all times. A loose contact surface offers high resistance and develops heat. This causes increased oxidation of the copper contacts. As copper oxide is not a good electrical conductor, this oxidation creates still more resistance and heat. This action is cumulative and eventually causes deterioration of the entire contact assembly.

When contacts open and close, rolling or rubbing action combined with the slight burning of a normal arc combine to keep the contacts bright and clean. If the contacts operate infrequently, the cleaning action does not occur and a covering of copper oxide develops. The heating-oxidation cycle may start and eventually overheating may develop even though the current or load is normal or less. For such conditions, silver contacts will probably give better service as silver oxide is a good conductor and heating does not develop. Silver contacts may also provide some relief in cases where a small overload condition is troublesome. They must, however, be used with some caution because they will not correct overheating caused by loose connections. As silver has a lower melting temperature than copper, silver contacts are more prone to beome soft and "weld" or "freeze" together when subjected to high arcing temperatures.

Other special alloy materials are available that give reasonably good service under certain unusual or specific conditions. Contacts made of special materials should be used only on advice of the manufacturer of the device. Usually they are rated at lower current-carrying capacities than similar contacts of copper or silver.

The closed pressure of contacts is an important factor in their ability to carry current. A small contact with suitable contact pressure will carry more current than a larger one with little or no pressure. Renewal of thin contacts is required, as with wear they lose their contact pressure. It is important to keep the contact springs in good condition. Replace them if they have been damaged or have lost temper through exposure to high arcing temperatures.

Where process operations permit, a monthly inspection of contacts for pressure, available life, surface condition, temperature and tightness should suffice for normal conditions.

Renew Frayed Shunts

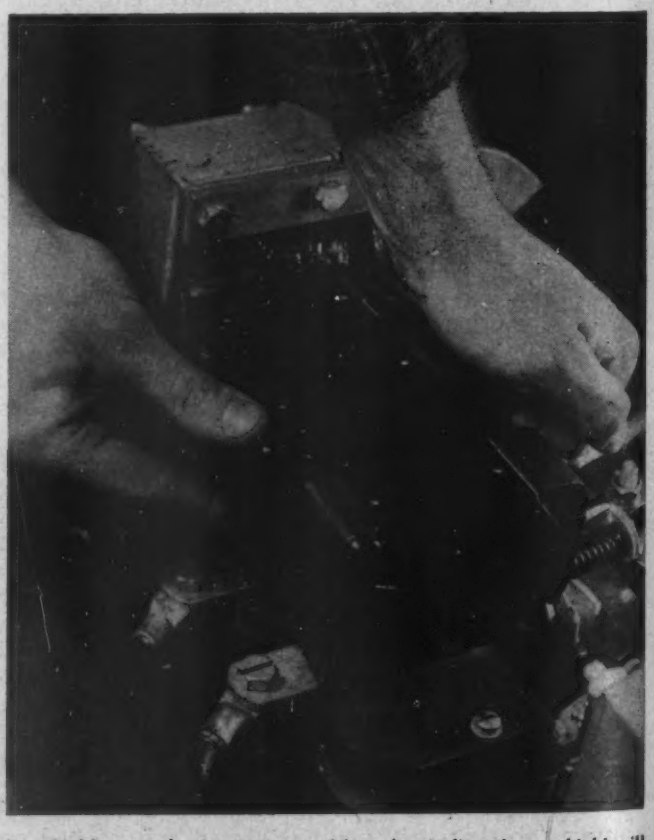
Shunts generally are flexible bands of woven copper strands that carry current from the movable contacts to a stationary stud. If the shunt is unduly bent its strands break and cause additional loading of the remaining strands.

Shunts with broken strands should be renewed to prevent overheating. The terminal connections of the shunt should be tight. Manufacturers frequently silver-plate shunt ends or cover them with special finishes to insure a clean contact surface of good current-carrying ability.

Coils Should Operate at Rated Voltage

After coils are wound they are treated with insulating varnish to improve their di-electric strength and make them a solid mass. This makes the coil less susceptible to mechanical injury, eliminates air pockets within the winding and enables the coil to radiate heat more readily than an untreated coil.

Alternating-current coils are designed to withstand



Arc shields must be in correct position. A misaligned arc shield will seriously decrease the arc interrupting ability of the entire blowout structure and may interfere with the opening and closing of the contactor.

Contact pressures are very important and should be checked. Weak springs and overworn thin contacts will reduce contact pressures.

10 percent over-voltage and operate the devices at 85 percent of normal voltage. Direct-current voltage will withstand 10 percent over-voltage and operate devices at 80 percent of normal voltage.

Over-voltage operates a contactor or relay with more mechanical force and tends to shorten the mechanical life if allowed to prevail. Over-voltage also shortens the life of a coil because it operates at a higher temperature. Low voltage will cause sluggish action. The contact tips may touch but may not be forced completely closed against the contact spring pressure. Under such conditions the contact tips will most certainly overheat and probably "weld" together. Contacts may always seal closed.

On a-c service, the coil current is much higher while the contactor is closing than after it is closed. A-c coils are not designed to stand the open-gap or closing current continuously. If any mechanical interference prevents complete closure of the magnetic air-gap of an a-c device, its coil will soon be overheated.

Open-circuited coils are easily detected because they cannot operate the device. Proof of open-circuit may be had by disconnecting the coil and testing with a "megger," or by substitution of a new coil. A coil with some turns short circuited might operate, but it would soon over-heat and burn out. Since most designs permit quick replacement of parts, a questionable coil could be replaced by a new one and the operation of the unit then checked for satisfactory performance.

Dead-Center Opening Reduces Mechanical Vibrations

When a magnetic contactor opens, the movable part strikes the stationary stop rather forcibly. There is a "dead point" or center of percussion, at which the effect of the blow is minimized. If the striking occurs at some other point the device is subjected to mechanical vibrations and strains that reduce its mechanical life. If the design of a contactor properly locates the armature stop with respect to the center of percussion point, undesirable shock and vibration of parts will be reduced and the mechanical life of the entire device will be increased. This is vividly illustrated by the "sting" of a baseball bat if the ball is struck near the end of the bat. This, of course, is a feature of design not involved in maintenance practice, but one which obviously affects the operation and life of the equipment.

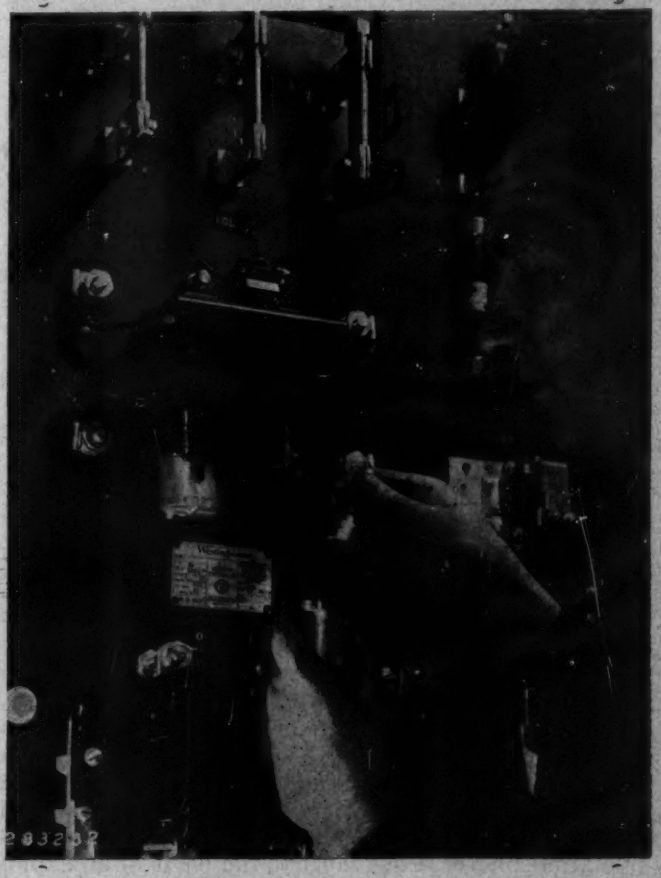
Dirt or Rust May Be Cause of Excessive Noise

D-c contactors always operate quietly when closed. A-c contactors may be noisy.

The laminated magnetic structure, necessary on a-c designs, must be held tightly together by screws, rivets or other means. If the laminations become loose the assembly will be noisy.

Noise will also result if the movable and stationary pole pieces do not fit well together when the device is closed. Dirt or rust may prevent proper closure of these surfaces and cause objectionable noise. To prevent rust on these fitted surfaces during shipment some grease is applied. The excess grease should be removed when placed in service to eliminate a "sticking" or sealing effect when the surfaces are first closed against each other.

The most important device in reducing noise of an a-c device is the shading coil usually imbedded in a part of the laminated magnetic structure. This coil is often a single turn of wire or strap and if broken the

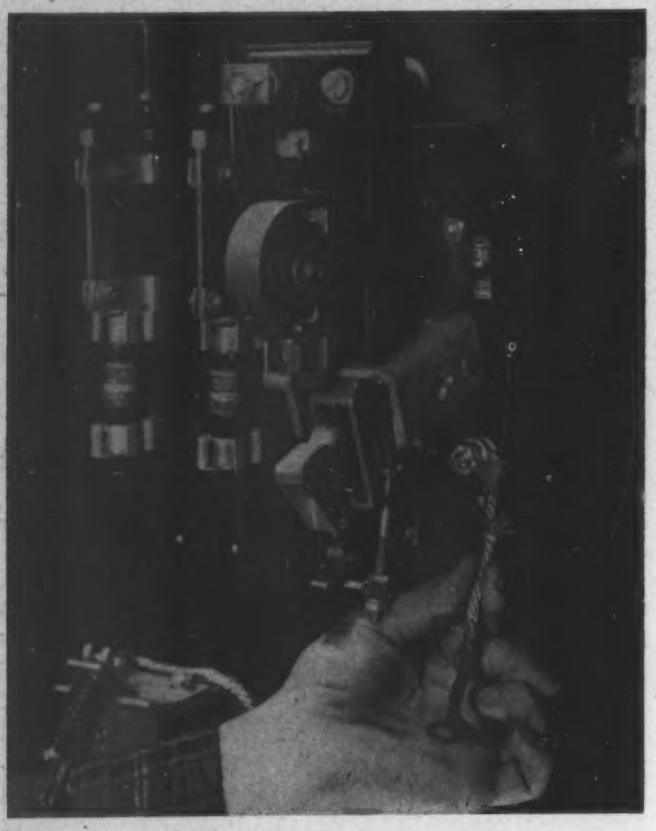


Massive contacts like these minimize the effects of heating and provide extra contact material to prolong service life.

noise will be most objectionable. If contactor is noisy, look first for a broken shading coil.

Oil-Immersed and Explosion Tested Control Used For Severe Service

For high-voltage installations, and for high- or low-voltage applications in explosive atmospheres and areas of corrosive nature, such as acid fumes, the entire equipment is often completely immersed in oil. The oil should always be maintained at proper level



Broken strands of shunts cause the remaining good strands to carry more current and eventually overload the shunt and cause it to overheat. Damaged shunts should be renewed.

and must be kept clean, since it serves as the insulating medium. Where permitted by process operations, monthly inspection of oil-immersed equipment is adequate unless service is severe and the oil deteriorates unusually rapidly.

It is a matter of experience that oil-immersed contacts undergo a more rapid deterioration than do air-insulated contacts, for similar service conditions. Recognizing this tendency toward shorter contact life, some manufacturers provide extra-large contact tips on oil-immersed control, the more massive contacts providing not only more material to extend contact life but also more capacity to distribute localized heating and more area for heat transfer to the surrounding oil. It is also apparent that contact pressure is particularly important in oil-immersed starters.

"Explosion-tested" starters of the air-insulated type are intended for use in explosive atmospheres without requiring oil. These starters are built to specifications of the Underwriters' Laboratories. The enclosing cases are built to withstand high pressures that occur within the case if internal explosions should occur and to prevent flames escaping into the explosive atmosphere. If dismantled, the parts of an explosion-tested starter must be carefully assembled making sure that all bolts, nuts and joints are tight and that matching surfaces are unimpaired. Operation in the explosive area, unless properly and completely assembled, is unsafe.

Overload relays of the dashpot type require frequent regular inspection to be sure that the dashpots are free of friction and not rendered unreliable or inoperative by foreign material particles. Of course the proper amount and type of oil must be maintained. No substitution of oil or liquid used in dashpots should be made. These liquids are tested for certain characteristics such as change in viscosity with temperature changes. A change in oil or liquid would therefore affect the operation of the relay.

Thermal relays are subject to ambient temperatures and should be in a room temperature equivalent to that in which the motor is located, otherwise the relays may not operate to the best advantages. For example, a thermal overload relay should not be in a temperature much in excess of the motor-room temperature unless proper allowance for the difference in temperature is made when the thermal heaters are selected.

Connections Must Be Tight and Clean

Loose connections are a frequent cause of trouble. They result in over-heated parts that eventually must be replaced. Once tight does not mean they will remain tight. Periodic inspection is necessary. Changes in temperature, vibration and carelessness are all common causes of poor connections. They should always be tight and clean.

Resistors to dissipate heat frequently fail from excessive temperatures. If enclosed they may require only some or better ventilation. Overheating may be caused by overloading or more continuous service than was anticipated in the design. Loose connections often cause local heating with eventual burned connectors. Grid or cast types sometimes break in handling or with frequent and sudden overheating and cooling.

Keep Starters Clean and Dry

Since many parts of contactors and relays are made of steel and subject to rust, these parts are always covered with a protective coating such as zinc or cadmium plating. Copper and brass parts are often treated with a light finish to protect against oxidation and for sake of appearance. Steel cabinets are painted; small sizes often have baked finishes. Galvanized sheet is often used to give added assurance against corrosion. However, moisture, dirt and dust are constant sources of trouble as they reduce insulation values of insulated wires and cables. They constitute a leakage path across which breakdowns occur between points of different potentials that would never occur on clean and dry surfaces. Routine maintenance should remove dirt and dust by blowing with dry compressed air, wiping or washing with suitable cleansing fluid. Compressed air under too much pressure may drive metallic dust and dirt into insulation or lodge particles between stators and rotors of motors or in moving parts of contactors and relays.

Moisture may occur from condensation, humid atmospheres, spray or overhead dripping. Heaters are sometimes placed in enclosures to keep the interiors dry. They are generally arranged to be automatically effective when the equipment is idle because the normal heat of resistors and coils is sufficient while in operation. Drip-proof, water-tight and dust-tight enclosures may be provided for protection from external elements; however humid atmosphere conditions may

■ CONTINUED ON PAGE 124

CARBON BLACK

PART 2

J. F. GALLIE,

Natural Gas and Natural Gasoline Division, Petroleum Administration for War

IT HAS been the wartime task of the carbon-black manufacturer, working in conjunction with the tire compounder, to fill the remaining gaps: to develop blacks which, if not outstanding in any single property, would prove outstanding in their possession of above-average over-all qualities. That task has largely devolved upon the coarser-particle furnace and thermal blacks, certain desirable qualities of which were recognized from earlier use in natural rubber. With the expansion of motor-transport service in recent years and increased size and speed of trucks and buses, heat generation became a serious problem, proving responsible for many tire failures. Experience gained in surmounting that difficulty has been applied to good advantage in wartime; first, in compounding natural rubber with increased percentages of reclaim (also heat generating), and in compounding for the overloaded driving of the mechanized forces in hot climates; and second, in producing tires largely from synthetic rubber, itself high in hysteresis. Properties of the coarser blacks favorable to such use have been summarized by Wiegand[17] in Figure 16.

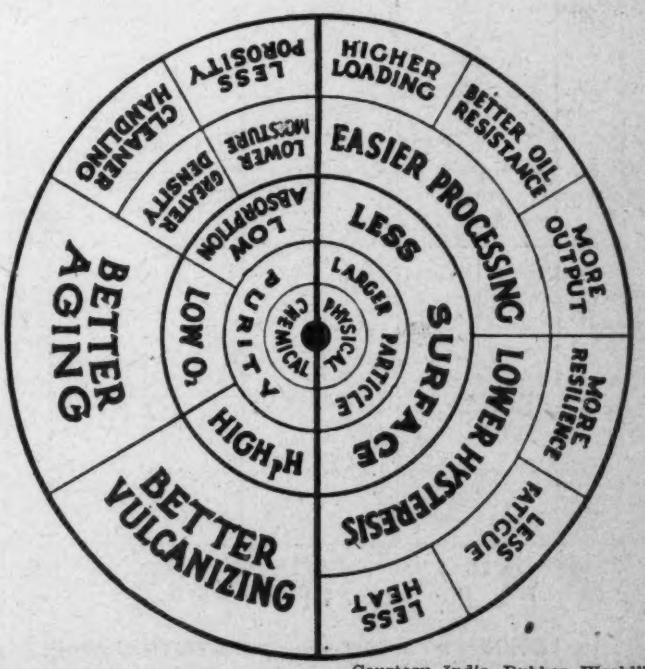
How well the carbon-black manufacturer has succeeded in filling existing gaps may best be gauged by reference to Figure 17, which draws comparisons between individual properties of eight blacks at loadings ranging from 20 to 75 parts per 100 of Buna S. The charts were prepared from data contained in a summary, issued by the Office of the Rubber Director, of a 350-page "Survey Study of Carbon Black in GR-S" undertaken by B. S. Garvey, Jr., and J. A. Freese, Jr., of The B. F. Goodrich Company.

It has been deemed advisable to draw two curves on the reinforcing furnace blacks because of the somewhat anomalous behavior of Philblack, produced with degraded oil as the principal base stock. Outstanding among the properties which these medium-loading blacks impart to GR-S in compounding is high modulus (even above that of the contact carbons) which is resulting in an increased demand for them. Regarding these related blacks, the comments of the chief of the WPB's Pigment and Color Unit, Thomas J. Starkie, are of interest:

> The medium loading reinforcing types of furnace carbon black . . . are growing in demand and will do so both during and after the war. This type of black definitely imparts low hysteresis to any rubber compound with greatly increased modulus and fairly good tensile . . . However, its one fault is poor abrasion, but since it improves so many other factors in the pigmentation of Buna S type synthetic rubber, we can readily accept the poor abrasive qualities. The furnace carbon blacks in this classification are being improved constantly, and I predict a carbon black will be made in this type of furnace which will equal the properties of channel carbon black.
>
> This type of carbon black (medium-loading reinforcing) has also high electrical conductivity, which is vital in the manufacture of many rubber products, whereas all grades of channel carbon black have extremely low electrical conductivity properties. When it is perfected, it will contribute a definite answer to the conservation of our natural gas resources, since it will be possible to get at least 5 pounds of the medium-loading-reinforcing type of furnace carbon black per thousand cubic feet of gas, or will more than double the present yield of channel type black per thousand cubic feet.

Wartime Operation of the Carbon Black Industry in Connection With the Synthetic Rubber Program

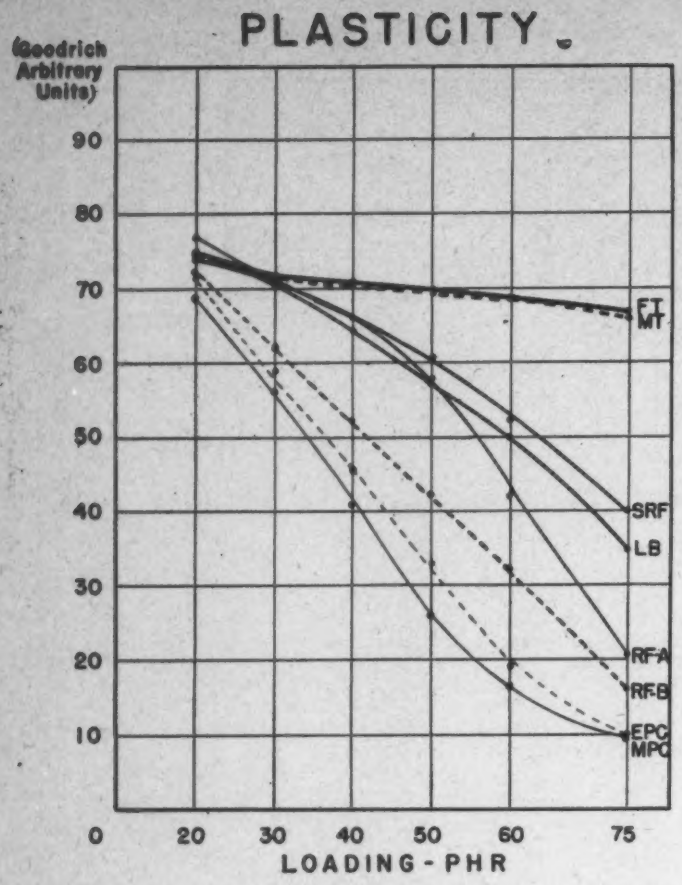
In wartime the carbon-black industry is under the jurisdiction of two governmental agencies—the War Production Board, through the Office of the Rubber

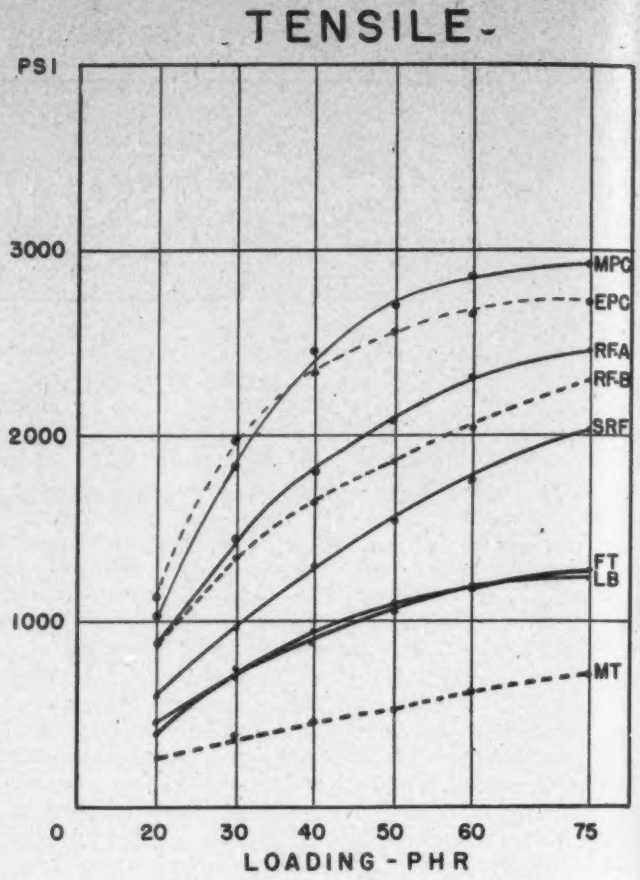


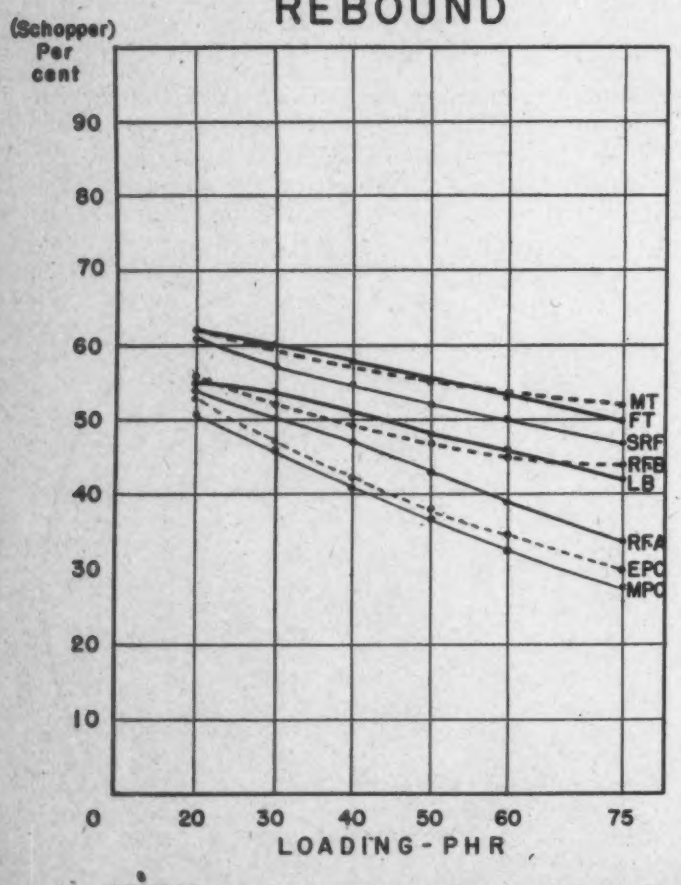
Courtesy India Rubber World[17]

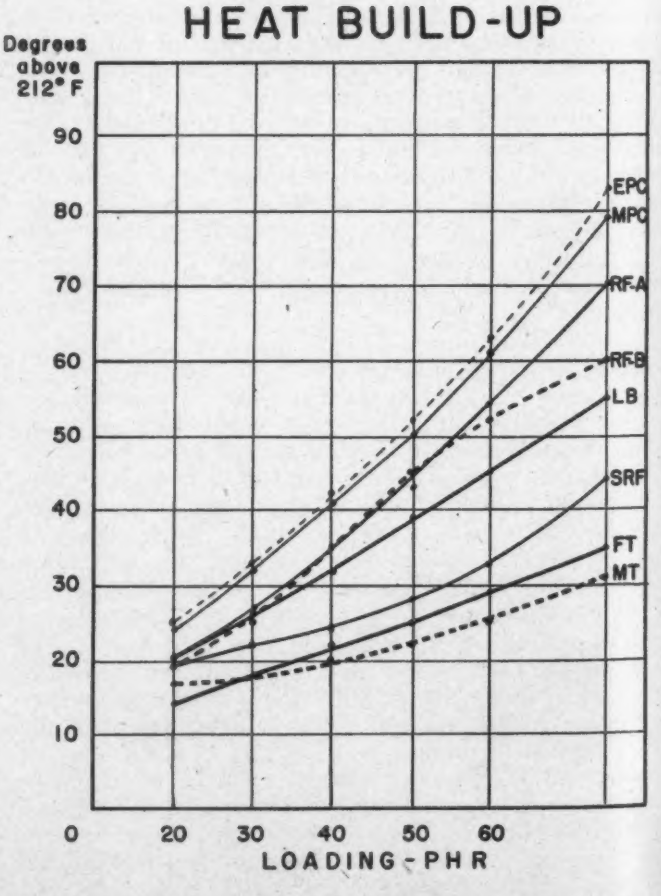
FIGURE 16

Advantages of semi-reinforcing carbon blacks in natural and synthetic rubber compounding.





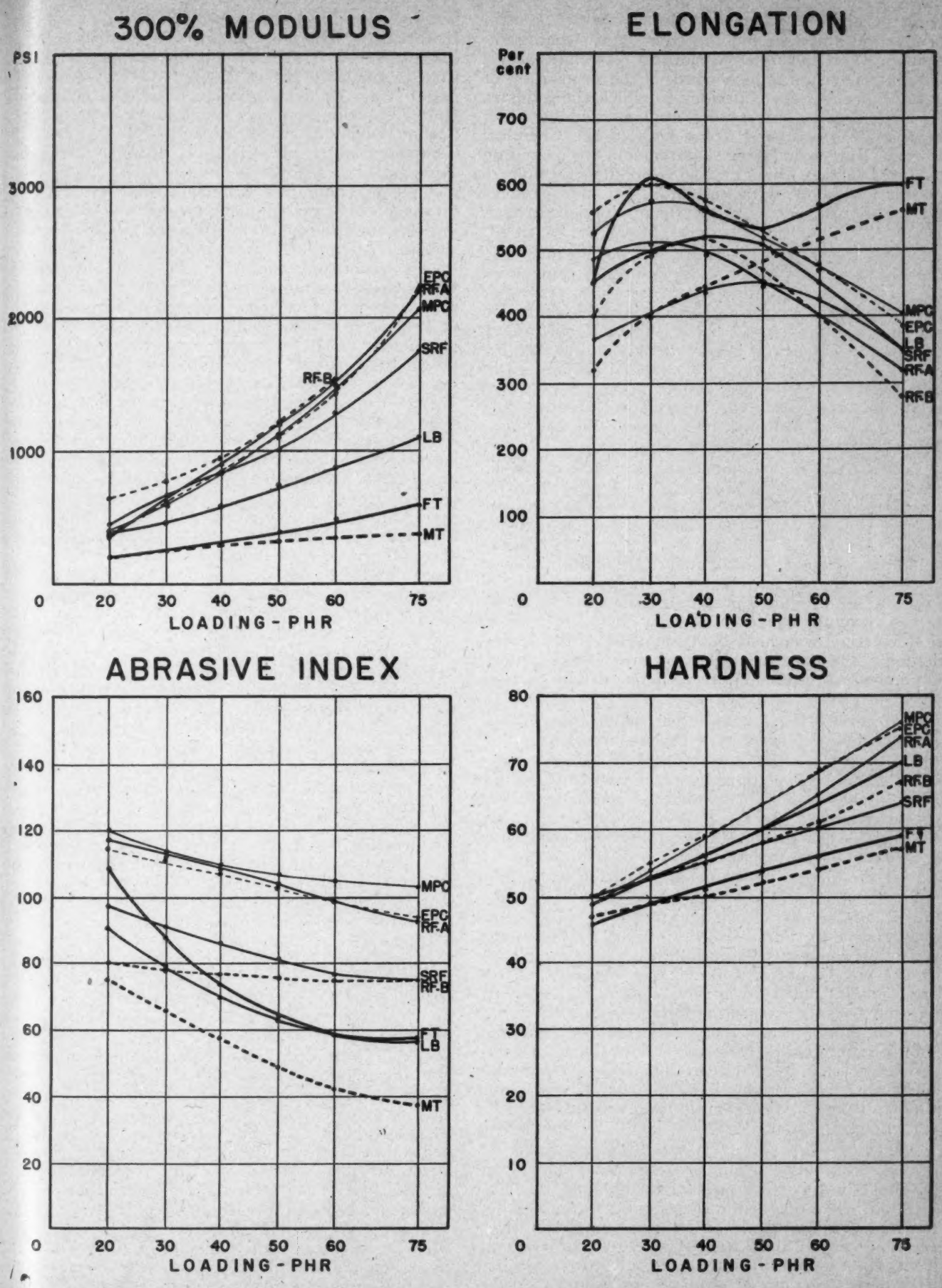




LEGEND– MPC:= MEDIUM PROCESSING CHANNEL (AVG.7) EPC:= EASY PROCESSING CHANNEL (AVG.8)
SRF·=SEMI-REINFORCING FURNACE (AVG. GASTEX AND KOSMOS 20) LB:= LAMPBLACK

FIGURE 17

Comparative properties of



RF-A:= REINFORCING FURNACE SUB-GROUP A (STATEX) RF-B:= REINFORCING FURNACE SUB-GROUP B (PHILBLACK) (AVG.6) FT:=FINE THERMAL (P.33) MT:=MEDIUM THERMAL (AVG. SHELL AND THERMAX)

FIGURE 17

blacks in synthetic rubber

Director and the Chemicals Bureau, which control production and use, and the Petroleum Administration for War, through the Natural Gas and Natural Gasoline Division, which controls the production of natural gas. WPB regulations to which the industry is most directly subject are implemented by Chief Starkie's Pigment and Color Unit of the Chemical Bureau. Rubber-industry requirements are passed on by the ORD to Chief Starkie, who then formulates production plans with the industry and arranges diversion of the necessary gas for production through PAW.

When the Japanese struck in the Pacific, they quickly seized control of Malaya, whence came some 90 percent of this nation's annual rubber crop. For several months thereafter, there was much confusion and uncertainty, as the Baruch Rubber Report noted. When the situation began to crystallize, it became evident that America's natural-rubber stockpile, plus the limited production of synthetics which might be expected in the latter half of 1943, would have to stretch well into 1944, despite the enormous demands made upon it by the military.

Recognizing that tremendous demands would be made of the carbon-black industry in connection with this extension of the rubber supply, and well aware through his 20 years association with that industry of the part that the furnace and thermal-type blacks could play therein, Starkie undertook organization of a Carbon Black Manufacturers Industry Advisory Committee, providing representation to manufacturers through delegates of their own choice. The first meeting was held September 10, 1942—coincidentally, the date of release of the Baruch report. Objectives of the committee, as delineated by Starkie, were:

(1) To assure the synthetic rubber program a sufficiency of furnace-type carbon black.
(2) To consider the possibilities of using present channel-type equipment to manufacture an acceptable carbon black for the synthetic rubber program.
(3) To discuss the production of easier processing channel-type carbon black.

Past production figures were reviewed, and it was pointed out that plans to meet estimated consumption should be made early, and that the critical situation relative to the availability of steel and electrical collecting apparatus, essential in furnace-type plants, should not be overlooked. Starkie also advised the group that Rubber Reserve Company had been requested to submit information on synthetic-rubber compounding, but that industry members should also submit individual reports on the desirability of using furnace or channel blacks in Buna S. As large-scale synthetic-rubber production could hardly get under way until late in 1943, ample time was available for such determination.

Evidence that utmost cooperation could be expected, both between industry and government, and within industry itself, was forthcoming at this first meeting, when one of the companies represented distributed to all delegates an extensive report on furnace-type carbon black as it related to synthetic-rubber compounding. Since then, the committee has met irregularly to consider progress in meeting production schedules and other matters of vital import.

As now constituted, the Carbon Black Manufacturers Industry Advisory Committee includes the following members: Thomas D. Cabot, Godfrey L. Cabot, Inc.; Reid L. Carr, Columbian Carbon Company; E. B. Curtis, Thermatomic Carbon Company; R. H. Eagles, J. M. Huber Company; L. C. Herkness, Charles Eneu Johnson Company; C. E. Kayser, National Gas Products Association; Oscar Nelson, United Carbon Company; Frank Perry, General Atlas Carbon Division; A. M. Rippel, Phillips Petroleum Company; and R. I. Wishnick, Continental Carbon Company.

A second committee, established to deal with technical aspects of carbon-black production, is also serving. Through the joint efforts of the WPB's Pigment and Color Unit and manufacturers represented on these committees production of desirable furnace-type blacks was increased more than 50 percent this past year. Additional plants placed in production late in 1943 or still under construction will increase 1944 production to 410 million pounds—about 300 percent above the pre-war level. Moreover, production has been increased swiftly, yet cautiously. Producers versed in the manufacture of furnace and thermal-type blacks have been given the "go-ahead" signal on plant expansion; those who had produced only contact blacks or who had not previously produced any type of black, were required to build pilot plants to prove the worth of their proposed manufacturing methods. Also of interest is the fact that the gigantic expansion involved has been accomplished wholly through private expenditure; no diversion of government funds to the construction and expansion of more than a dozen plants capable of fulfilling all wartime requirements has been required.

The Report of the Rubber Survey Committee recommended that a Rubber Administrator be appointed to the War Production Board, with full authority over all phases of the Rubber Program—research, development, construction, and plant operation. When the Office of the Rubber Director was established in accordance with that recommendation, and placed under William M. Jeffers, he found that at least one corollary program—that pertaining to carbon-black production — was in capable hands. Rubber-industry needs had been established and the groundwork laid for increased production; some new plants were, in fact, already under construction. As a result, Rubber Directors Jeffers and Bradley Dewey have been content to leave the carbon-black production program under full control of Pigment and Color Unit Chief Starkie.

In relating properties of carbon blacks and synthetic rubbers on a mass scale, the Office of the Rubber Director has provided a strong integrating force, so necessary to the success of the synthetic-rubber program. All loose ends have been drawn together and knit into a workable whole. Manufacturers are working together ceaselessly in their attempts to remove all kinks from synthetic-rubber compounding, and are experiencing a high degree of success. United States Rubber Company's Ludwig Meuser, at the dedication of the synthetic rubber plant at Institute, West Virginia, stated that in the past 30 months as much progress has been made with synthetic rubber as was made in the preceding 30 years with natural.

Through the ORD all tests on synthetic rubber tires are given general distribution throughout the tire-compounding industry. Four test fleets are now steadily employed in the United States, and full reports of their activities, together with complete data on the ingredients and cure of rubber stocks used in the tires tested, are circulated immediately upon completion of a test series. The comprehensive re-

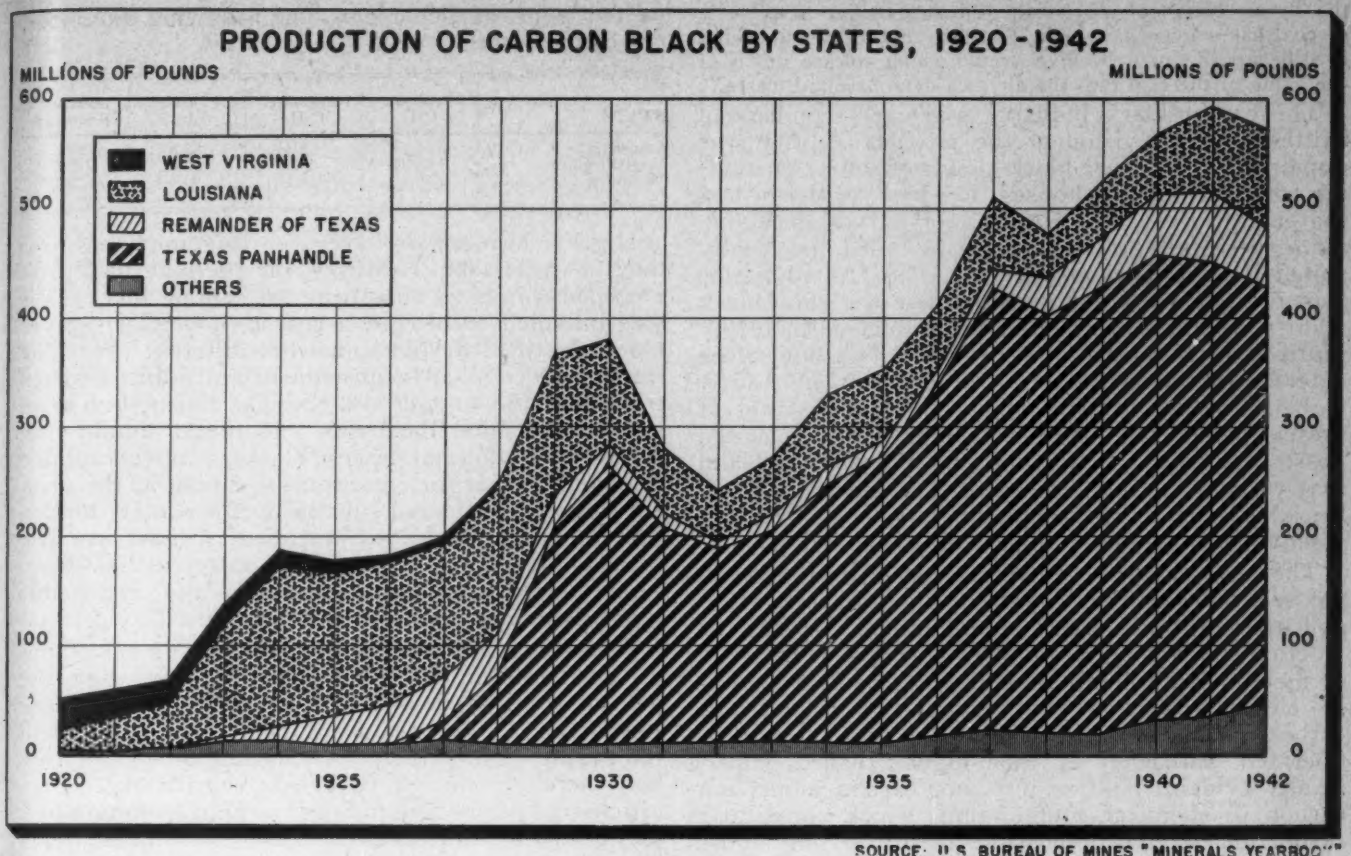


FIGURE 18

ports are accompanied by photographic detail, and are therefore complete in every respect.

Upon the determination of flaws, or improvements over preceding tests, and the ingredients of processing responsible therefor, the rubber mix may be altered in whatever respect may appear desirable, whereupon further tests are made. By a process of selective elimination, synthetic-rubber tires possessing the most desirable qualities are being evolved with relative rapidity. Consider the task that would be set the industry if each compounder had to carry out comprehensive tests of his own, and there was no general dissemination of the information gleaned from each test!

Carbon-black requirements have, as might be expected, changed even as requirements for other products. However, sufficient flexibility exists in contact manufacturing methods, on the one hand, and furnace and thermal processes, on the other, that the minor production adjustments thus far necessitated have not disrupted the steadily increasing flow of carbon black to tire manufacturers. There exists the fullest cooperation, as well as complete coordination of effort, between WPB's Office of the Rubber Director, the same agency's Chemicals Bureau, and PAW's Natural Gas and Natural Gasoline Division. In no other manner could demands have been so successfully countered even before they arose.

Some Considerations of Carbon Black Production

Cheap natural gas is fundamental to the carbon-black industry. It was in the existence of a plentiful supply in the Appalachian fields during the early days of their development that the industry had its origin, in a period when gas was considered a necessary production evil and was largely being blown to air. The marked reduction in the selling price of carbon black which took place in the first years of the industry's life—from $2.50 per pound in 1872 to as low as 4 cents in 1889—was principally a measure of increased demand, heightened competition, and greater manufacturing efficiency.

When compressor equipment was made available in the 1890's for use in transporting natural gas to nearby cities for lighting, cooking, and heating, natural gas assumed greater economic importance, and its price in West Virginia rose from 2½ cents per thousand cubic feet to as high as 20 cents. Carbon-black manufacturers found it impossible to compete for their raw material at the higher rates, and it was then that the industry necessarily became, as Moses[18] noted, "peripatetic, or nomadic, journeying from one gas field to another, ever in search of cheap gas."

In 1916, when the 250,000-acre Monroe, Louisiana, gas field was first drilled into, the industry was producing about 25 million pounds of carbon black per year. With the demand increasing, and with gas cost rising and the supply declining in the Appalachian area, the industry shortly thereafter began its migration to the Southwest, settling in this remotely located field. From 1921 until 1929, when total production exceeded 350 million pounds, Louisiana ranked first among carbon-black producing states. In 1929 the Texas Panhandle took the lead, and in each succeeding year has exceeded the total annual production of any year prior to 1926. Production by states, 1920-42, is given in Figure 18.

In *The Tragedy of Waste,* Stuart Chase wrote:

"The technique of production and distribution is based on the current status of the arts of engineering, physics, chemistry and administration. A stream can rise no higher than its source, and waste only appears when a given process is carried on at a lower level than the present state of human knowledge warrants. To give a specific instance,

the by-products coke oven for the destructive distillation of coal has proven its worth. The fact that so much coking is still carried on in beehive ovens, which release much of the value of the coal into the air, is a demonstrated waste."

The carbon-black industry was early condemned by those whose vision of the product's utility was impaired by the dense black clouds of smoke emanating from the burning houses. The basic criticism was that the process was wasteful of natural gas and, more specifically, of natural gas intended and ideally suited for use as domestic fuel. The United States Bureau of Mines, in an investigation of carbon black and its processes of manufacture published in 1922,[19] refuted such charges, stating that: "Carbon black enters into the manufacture of printer's ink, automobile tires, paint, and other commodities and at present has no substitute. It is an economic good and possesses utility . . . It would be improper to claim that carbon black is less useful than zinc, glass, or brick, as each serves a definite purpose and each is essential and necessary for certain specific uses."

The manufacture of contact black from natural gas recovers less than 5 percent of the carbon available therein, or about 1½ parts out of 33. But the reaction involved is more than a simple conversion of methane, the chief component of natural gas, to its elements, carbon and hydrogen; further, some carbon is burned in order that other carbon may be liberated. Efficiency is, then higher than is superficially evident. And as it is not carbon alone, but carbon in chemical combination, which constitutes carbon black, it is impossible to utilize only those methods (furnace and thermal) which produce optimum yields, or even to use only the optimum yield contact method. Blacks produced with minimum as well as maximum yields have qualities that make them unique, not only from one another, but from all other blacks.

In earlier days, printers often held a pan above a tallow candle to secure a small supply of carbonaceous pigment, so necessary to their industry. The production of contact carbon black, which had its derivation therein, is a fundamentally simple operation. When this is understood, it is not difficult to see why the fundamental procedure has altered so little in the four-score years since J. K. Wright first made carbon black. Such changes in operation as have been made have been but refinements: in the design of burner tips; in the rate of gas flow; in the distance between burner and channel; in drafting and ventilation, which regulate the height of the smoke pall hanging cloudlike within the roofs of the burning buildings; in the time which the carbon particles, once impinged, are permitted to remain on the smooth surface within reach of the gas flames wherein they are formed.

Carbon-black manufacturers, by amassing data on their product through the aid of competent technical staffs, have increased the yield somewhat. In the course of the past two decades, it has risen .1-.2 pound per thousand cubic feet of gas. While this is not a great increase, it does represent 8-16 percent. Too, it must be taken into consideration that gas in Texas and Louisiana, where most carbon black is now produced, has a lower carbon content than gas earlier available. Not only was more carbon available for conversion (by virtue of higher ethane constituency) in, for instance, West Virginia or Wyoming gas than is to be found in the nearly identical Louisiana and Texas gases, but representative yields indicate that a higher percentage recovery may be expected from the richer gas. The following analyses[19] are of interest:

STATE	Percent CH_4	Percent C_2H_6	C/MCF (Lbs.)	Percent Recovery
Louisiana	94.1	3.4	33.8	2.4
West Virginia	65.2	30.1	42.3	2.6
Wyoming	46.5	43.1	44.3	3.1

High-yield methods have been in commercial production since 1922. However, the thermal black first obtained was not a substitute for contact black, as it was intended to be, but a coarse, low-color, grayer black, destined to find somewhat different uses. The furnace-process black subsequently introduced varied from both the contact and thermal blacks, but more nearly resembled the latter, and found similar use. Furnace and thermal process blacks, while acceptable or even superior for certain uses, cannot at the present time be considered substitutes for contact blacks. The more recent development of a finer particle thermal black may be considered a step in this direction, however, and it is certainly not impossible that other refinements will be introduced.

As no more efficient method of contact black manufacture has been developed than that now used, the present method does not bear condemnation. *The product is an economic good:* its use has resulted in the saving of hundreds of thousands of tons of rubber, thereby reducing tire costs remarkably. In an article on the uneconomic uses of petroleum and natural gas, Gill and Knight[20] estimated that in the years between 1922 and 1936 the saving to the public was upward of forty times the value of the natural gas employed in the United States for the production of carbon black, even when rated at the average domestic consumption well-head price per thousand cubic feet. *The product possesses utility* in addition: as a basic commodity upon which printers and publishers are dependent, it has brought knowledge, entertainment, and news to the world; in its manifest other uses, it has added strength and durability, therein providing a direct refutation of its reputed economic wastefulness.

What, then, of criticism to the effect that the use of natural gas in carbon-black production has served to deplete reserves which would otherwise be available for domestic consumption? An analysis of gas production and consumption throughout the life of the carbon-black industry provides a ready reply. Certainly no justification is necessary for such use in the days when the usefulness of gas was considered to end with the expulsion of oil from the reservoir—when it was then being blown to the atmosphere. But since transmission facilities were developed, opposition has been voiced, not infrequently, to carbon-black production. As early as 1918, State Senator Leon R. Smith vociferously objected to settlement of the carbon-black industry in Louisiana, pointing out that the entire requirements of the city of Shreveport might be supplied for 3½ days with the natural gas made available to a single carbon-black manufacturer for less than $50.00.

Louisiana is one of the oil- and gas-producing states which subsequently enacted regulatory legislation over the carbon-black industry.[18] However, it is legislation designed to diminish waste, not use, and is of consequence effective and just. Permits for production are issued for periods of one year, but can be issued by special authority for as long as 25. Requirements are that the gas be burned economically

and efficiently, and that gasoline content in excess of 150 gallons per thousand cubic feet first be removed. The amount of gas to be used is established by the Department of Conservation, and monthly reports on gas use and production are required to assure adherence to these restrictions.

Early in 1923 the industry entered Texas, when a plant costing $300,000 and designed to convert 10 million cubic feet of gas per day into carbon black began operation in Stephens County. Development of the Panhandle Field was intensified in the middle 20's, and in 1926 Western Carbon Company began operation in the Carson County area, utilizing residue gas from a natural gas plant. In the ensuing years the industry has centered its activities in this huge field.

C. A. Warner, in his text on *Texas Oil and Gas Since 1543,* states that "The history of the production and dissipation of gas from the huge Panhandle reservoir is one of profligate waste from about 1927 until very recent years." Governing legislation designed to curb this waste has not differed greatly from that in Louisiana with one important exception planned to make maximum use of the large quantities of sour residue gas from natural gasoline plants in the Panhandle Field. Whereas the use of such gas may result in corrosive damage to plant equipment, it can be most readily utilized, without purification, for carbon-black production. Such legislation is, again, designed to make optimum use of the state's natural-gas resources, and is both fair and wise.

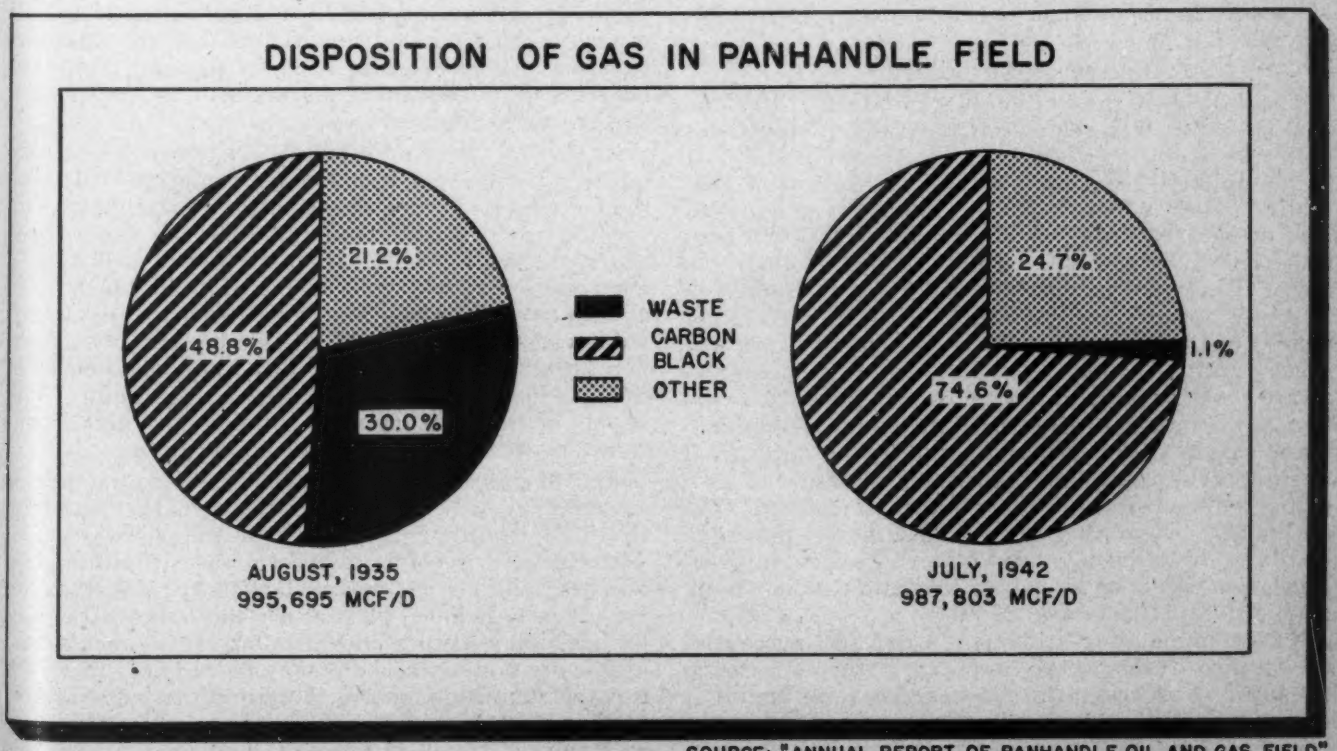
In 1931 the state began its attempts to equalize the production and sale of gas with issuance of its Common Purchaser Act. This was ruled out by the courts, and a second similar attempt failed in the following year. In 1933, passage of the Sour Gas Law permitted use of 25 percent of the open flow for other purposes when there was no reasonable market for light and fuel available to the owner. The immediate result was expansion of natural gasoline production, and as high as 1 billion cubic feet of residue gas per day was being vented to the air in 1934. Against this was an average daily gas use in the same year of less than half that amount. In recognition of this wastage, the Texas Railroad Commission's Annual Report on the Panhandle Field notes:

> The oil wells in the various pools in the field were, as a general rule, drilled through one or more gas-containing strata before entering the oil horizon, and in many instances, the wells were completed in such a manner that gas from the gas strata was produced along with the oil and gas from the lower oil stratum. As a result a quantity estimated to be in excess of two trillion cubic feet, a large part of which came from the upper gas strata but was produced with the oil, has been wasted into the air.

House Bill No. 266, which was passed in 1935, prohibited the production of gas in excess of distribution facilities or market demand. In the following two years this measure cut 200 billion cubic feet from the 1935 state wastage figure of 380 billion, or more than halved it. In the Panhandle Field alone a remarkable change was effected. Between 1935 and 1937, according to the Railroad Commission Report, gas wastage dropped from 30 percent to less than 5 percent. Figure 19 illustrates the extent of the change in the past seven years.

The carbon-black industry had greatly expanded its production in the Panhandle between 1927 and 1930, thereby effecting use of 350 billion cubic feet of gas which would otherwise have been blown to the air. Between 1935 and 1937 this expansion was continued, but even so, annual use for carbon black production has not equalled the waste of earlier days. In Figure 20-A, known loss and wastage in Texas has been plotted against gas used in the Panhandle Field in carbon-black production. Figure 20-B reveals similar figures for the United States as a whole.

Between 1935 and 1941, less than 2.3 trillion cubic feet of gas were used for carbon-black production, while 4 trillion cubic feet were lost or wasted, according to data published in the United States Bureau of Mines Minerals Yearbook. As long as gas wastage, which represents by far the larger part of



SOURCE: "ANNUAL REPORT OF PANHANDLE OIL AND GAS FIELD"

FIGURE 19

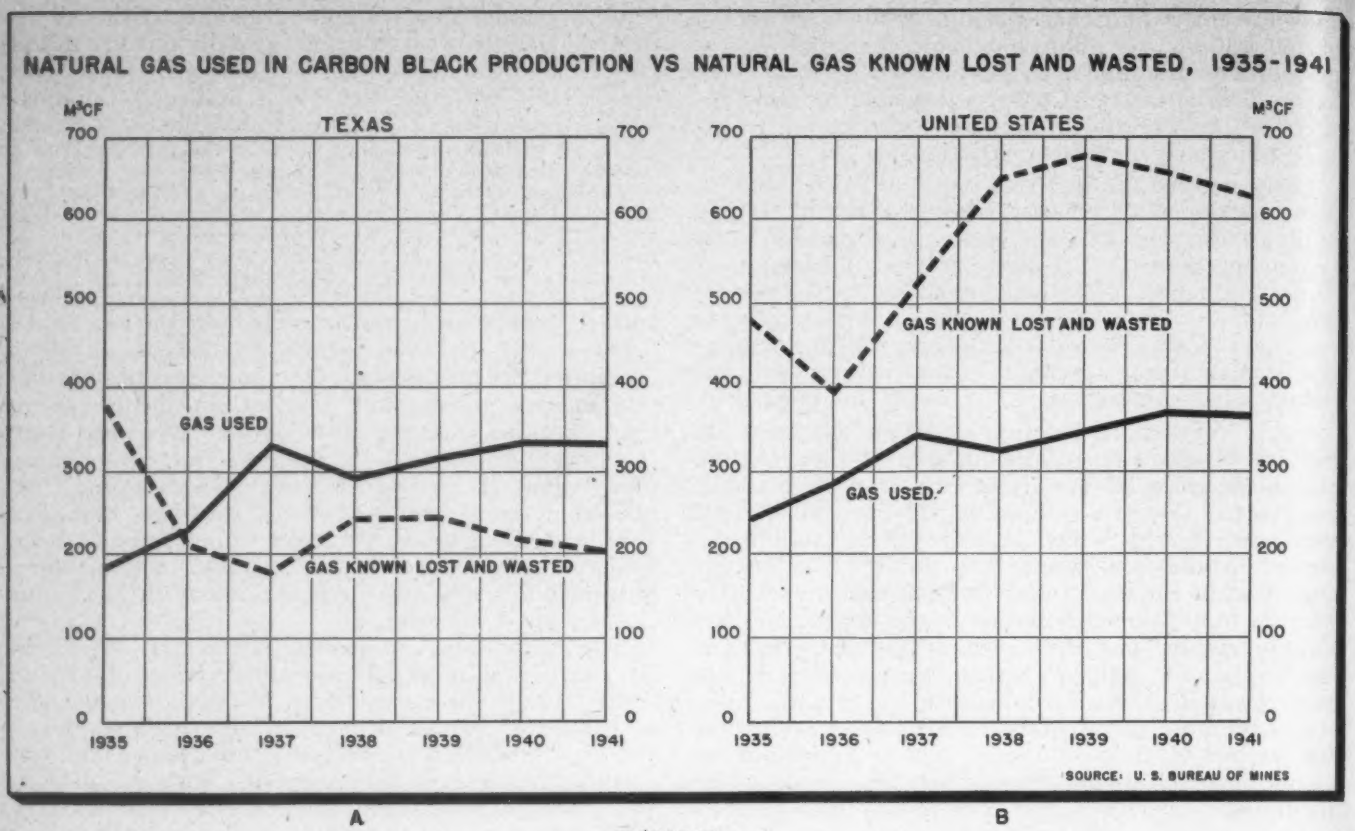


FIGURE 20

the combined loss-wastage curve, exceeds the use of gas in carbon-black production, any criticism of the latter is irrational. While it must be acknowledged that much flareage occurs in widely separated areas, in fields which could not economically support erection of carbon-black plants, the foregoing review of developments in the Texas Panhandle field from its discovery until very recently provides an outstanding example of known waste. True conservation obviously is to be found in the diminution, not of use, but of waste.

Future of the Industry

The future of the carbon-black industry, like the past, is intimately related to the rubber industry—more particularly, to that of tire compounding. It seems unlikely that annual world production of synthetic rubber, which will very nearly have equalled that of natural rubber before war is ended, will continue on a comparable scale. However, Rubber Director Bradley Dewey's article, "What About the Postwar Future of Synthetic Rubber?" which appeared in the December, 1943, issue of *Chemical and Metallurgical Engineering*, makes us very definitely aware that the huge synthetic rubber industry is not just a wartime industry, scheduled for postwar oblivion. Dewey notes that he holds "no brief that synthetic rubber should continue after the war as a pampered, subsidized or protected industry," but he makes it clear that low-cost synthetics produced in the more efficient plants at a cost, excluding depreciation, of about 12 cents per pound can be wholly competitive with natural rubber.

Tire compounding ordinarily uses 70-80 percent of the annual rubber crop import; if longer-wearing tires can be processed from synthetics (and the ORD states that with proper care they will now give 90 percent as good service as natural rubber tires), it may be expected that use therein will be continued or expanded. Competition will undeniably exist for the raw materials used in the production of synthetics, and the relative worths of natural and synthetic rubbers in their innumerable end uses may be expected to tip the scales in favor of one or the other. In any event, postwar production of synthetic rubber may definitely be expected to continue on a scale without precedent in the prewar years. As carbon black imparts to it certain qualities already present in crude natural rubber, and as synthetic rubber is far superior not only to natural but to other materials as well in certain respects (among them, oilfield use), an additional market will be created for carbon-black producers.

In the 15 years preceding 1939, when war broke out in Europe, world rubber consumption had more than doubled. In the immediate postwar years, according to Knorr,[23] it will probably be some three times as great as it was in 1924. There will exist a need for extensive replacement of tires which have already worn thin in two years of war, and which will wear still thinner in 1944—perhaps in 1945. Rubber Director Dewey made this ominously clear in the first lines of Progress Report No. 4, stating: "The supply of tires and other essential rubber goods continues short and will be so for a long time . . ."

Reconversion of war plants to the manufacture of automobiles will likewise create a market for new tires and, in turn, carbon black, in the postwar years. The market for color carbons, of use in automobile finishes, will also be expanded thereby; and if, as we are given to believe, plastics are the order of the day in automobile bodies and in numberless other items, high-color-contact carbons may be required in vastly greater quantities for use therein. Moreover, carbon-black exports may be expected to resume their prewar upward trend. It appears, then, that the capacities of carbon-black plants will be taxed to the ut-

most in the years following the cessation of hostilities.

Therein lies a potential threat to America's 110 trillion cubic feet of proven natural gas reserves (the equivalent of a 30-year supply). For, as has been suggested, the expanded production of furnace and thermal blacks, while more saving of natural gas than contact methods, will not necessarily supplant, but merely supplement present production. The Natural Gas and Natural Gasoline Division of the Petroleum Administration for War has accordingly endeavored to locate carbon-black plants in those areas where gas was being blown to air in appreciable quantities. Where this has been impossible (and it must be borne in mind that economic considerations of the carbon-black manufacturer have dictated certain requirements, such as nearness to transportation facilities and consistency of gas supply), the assistance of governing state bodies has been requested and obtained in the release of gas for carbon-black manufacture for the duration and six months thereafter. This division is currently making the necessary arrangements relative to gas use for the War Production Board's program of expansion for contact carbon manufacture, requiring the use of some 70 billion cubic feet of gas annually for production of more than 100 million pounds of easy processing black.

If the prospects for 1944 and thereafter are that over 40 percent more carbon black will be produced than in 1941, with a consequent greater expenditure of America's natural-gas resources, there are also some favorable indications regarding manufacture. The development by Phillips Petroleum Company whereby degraded oil having little other use may be utilized with gas in the manufacture of a furnace-type black is highly significant, but no less is the development of a medium-loading reinforcing furnace-type black by manufacturers continuing derivation of the product from natural gas. In the event of continued large-scale production of synthetic rubber, indications are that these blacks will find greatly increased use.

Also encouraging to the nation's domestic consumers of natural gas are the results of experimentation in the use of other liquid hydrocarbon fractions for carbon-black production. Following Jakosky's publication of data relative to the use of such liquids in the manufacture of carbon black (to which reference was earlier made), Plummer and Keller[21] ascertained that propane, now used as a liquefied petroleum gas, could also be utilized to yield a carbon black possessing slightly improved modulus and tensile properties when compounded with rubber. Against its use (despite twice as great a yield) was, as Jakosky noted, the high cost and intermittent supply of such fuel.

In an address on "Cycling Operations and Potential Use of Products," given before the California Natural Gasoline Association last fall, PAW Natural Gas and Natural Gasoline Division Director James E. Pew made the following pertinent comments relative to the increasing availability of such stocks (which must necessarily result in a reduction of cost or improvement of technique) in the nation's condensate fields:

"The large quantities of liquid ethane-propane mixtures presently separated in cycling operations, but returned to the producing horizon in the absence of a market, will find that market with improvement of transportation and storage techniques. They bear consideration, in such event, as industrial liquefied petroleum gases. Several other possibilities suggest themselves: first, that they are potentially useful as manufactured-gas enrichment agents, and second, that inasmuch as it has been proved possible to produce carbon black from liquid hydrocarbons, and since higher yields have been noted with higher ethane content of fuels used, they would appear to be of potential importance in the production of this necessary item, in which 11 percent of the nation's total gas consumption was utilized this past year."

Much of the available data would appear to indicate that an equivalent product cannot be obtained from products other than natural gas—that quality must be considered as well as quantity; that the use of a mixture of heavier fractions, each possessing an optimum quantity—quality burning temperature different from that of the others, renders adjustment of burning temperatures extremely difficult; and that impurities are to be found in far greater quantities in such blacks. It then behooves the manufacturer to continue the experimentation begun by Francis,[23] who determined in 1931 that a high grade color carbon "equal in tinctorial power to, and apparently identical with, the best grades of carbon black now on the market" could be produced under pressure with a proven yield three times as great as that ordinarily obtained, and, at 30-60 atmospheres, an indicated yield eleven times as great. Methane, propane, gasoline, or even paraffin could presumably be utilized; upon the basis of the foregoing considerations, however, particular attention should be given the first two of these.

The most serious difficulty, according to Francis, lay in the required installation of expensive compressor equipment. With low-cost gas, it was cheaper to burn even five times as much gas per given yield than it was to install this additional equipment. The present need of this natural resource as a raw material in the gas-chemical industry, coupled with its predictable early use in alleviating the looming oil shortage applications for the construction of pilot plants for experimentation on the Fischer-Tropsch process for the synthesis of gasoline have recently been recommended in this Division of the PAW and priorities granted by the WPB), dictates that this proposed method of manufacture be fully reconsidered.

In the current year, carbon-black production in the United States will approximate 880 million pounds. This is nearly 50 percent above production in 1941, the previous peak year. In that production, approximately 400 billion cubic feet of gas—about the same amount as the Bureau of Mines reported used in the nation's 9 million metered dwellings in 1939—will be consumed. It is hoped that this report on carbon black has demonstrated that such consumption of natural gas is not only necessary, but wise.

The projected transportation of 73 billion cubic feet of natural gas from Texas to the Appalachian area for use annually by domestic, commercial, and industrial consumers therein has recently elicited criticism from a number of well-meaning individuals. Dr. Frank H. Dotterweich, acting head of the Department of Engineering at the Texas College of Arts and Industries and consultant with the Natural Gas and Natural Gasoline Division of the Petroleum Administration for War, took occasion to reply to such criticism recently in an address before the Corpus Christi Rotary Club on "The Future of Industrial Development in South Texas." Dr. Dotterweich pointed out that Texas is now responsible for

one third of the total waste of natural gas in the United States, and that this waste is in turn three times the amount required for the Tennessee Gas and Transmission Company pipe line. Annual waste, he suggested, could be diminished by use of this valuable raw material in the growing gas-chemical industry in this area, or by conversion to liquid fuel or export from the state through pipe lines, either of which would make the gas available for use throughout the nation.

The carbon-black industry will have to expand further this year to meet the 880-million-pound goal set for it by the War Production Board. This conversion of natural gas to carbon black is highly essential. It is well, then, to forestall any renewal of condemnation of carbon-black production in this center of the industry. Sight should not be lost of the fact that the manufacture of carbon black, involving combustion and thermal decomposition—two of the four important basic chemical reactions of methane—is not only of the new gas-chemical technology, which Dr. Dotterweich has given first rating in his program for the elimination of waste, but is, in fact, its nucleus.

BIBLIOGRAPHY

(Note: For a more complete bibliography on the subject, readers are referred to the Tulsa Public Library's Petroleum Bibliography No. 8 (Carbon Black), issued in October, 1942, and to the annual Industrial Arts Index. Only references directly quoted have been listed below, inasmuch as some 150 articles and texts were consulted in the preparation of this article.)

[1] "The Compounding and Processing of Government Synthetic Rubber," C. A. Carlton and K. B. Reinbold, The Rubber Age, October, 1942.

[2] Columbian Colloidal Carbons, Vols. I-IV, The Columbian Carbon Company, 1938-1943.

[3] Printing Ink, F. A. Wiborg, Harper and Bros., 1926.

[4] Inside the Flame and Industry Highlights, Godfrey L. Cabot, Inc.

[5] U. S. Bureau of Mines Minerals Yearbook, 1919-1942.

[6] "Notes on the Carbon Black Flame," W. B. Wiegand, Industrial and Engineering Chemistry, February, 1931.

[7] "Some Facts About the Manufacture of Carbon Black and its Use in Various Industries," M. W. Kriegel (Unpublished).

[8] The Electrical Manufacture of Carbon Black, J. J. Jakosky, U. S. Bureau of Mines Technical Paper 351, 1924.

[9] "The Development of the German Ersatz for Carbon Black," Hugo Fuchs, India Rubber World, November, 1941.

[10] Protective and Decorative Coatings, Vol II, J. J. Mattiello, John Wiley and Sons, 1942.

[11] "Natural Gas, Soot,—and Better Rubber," F. Burnham MacLeary, Appendix to Charles Goodyear, by P. W. Barker, Godfrey L. Cabot, Inc., 1940.

[12] "Rubber Compounding 1918-1938," William C. Geer, Chemical Industries, June, 1938.

[13] "Pioneering Carbon Black in American Tires," S. C. Stillwagon, India Rubber World, July, 1937.

[14] "Compounding: A Discussion of the Fillers, Reinforcing Agents and Softeners Used in the Compounding of Rubber," R. H. Seeds, A. S. T. M. Symposium on Rubber, 1932.

[15] "Manufacture, Properties and Uses of Carbon Black," A. W. Campbell, Rubber Age, October, 1941.

[16] A New Scientific Method of Grading and Specifying Rubber Carbon Blacks, Godfrey L. Cabot, Inc.

[17] "Further Electron Microscope Studies on Colloidal Carbon and the Role of Surface in Rubber Reinforcement," W. B. Wiegand, India Rubber World, December, 1941.

[18] "Review of Statutory Regulations in the Carbon Black Industry," Leslie Moses, Oil and Gas Journal, April 9, 1942.

[19] Carbon Black—Its Manufacture, Properties, and Uses, R. O. Neal and G. St. J. Perrott, U. S. Bureau of Mines Bulletin 192, 1922.

[20] "What are the Uneconomic Uses of Petroleum?," John D. Gill and E. T. Knight, Petroleum Development and Technology (A. I. M. E. Yearbook), 1938.

[21] "Production of Carbon Black from Propane," W. B. Plummer and T. P. Keller, Industrial and Engineering Chemistry, November, 1930.

[22] "The Flame—Pressure Process for Carbon Black." A. W. Francis, Industrial and Engineering Chemistry, November, 1930.

[23] "Rubber After the War," K. E. Knorr, India Rubber World, July-October, 1943.

[24] "Thirty Years Contributions to the Science of Synthetic Rubber," W. L. Semon, Chemical and Engineering News, October 10, 1943.

Maintenance of Motor Starters

Continued from Page 114

still cause internal condensation which must be dealt with. When checking the oil of oil-immersed starters, make sure that no water has accumulated in the bottom of the oil tank.

Moisture in conduits is a frequent source of grounds and other trouble frequently extended into the control itself of drainage from the conduit system. Any measures to prevent moisture in conduits are good insurance against trouble. Where necessary, condensation traps should be provided in the conduit system. Grounds cause false circuits that cause unexpected starts, prevent stopping by normal means, eliminate overload protection and cause unsatisfactory operation. When serious grounds develop they are eliminated by cleaning the conduit and installing new wiring. The insulation resistance should be checked regularly so that the presence of grounds can be detected and if possible eliminated before trouble occurs.

All wiring should be kept in safe and good condition. Vibration will cause broken wires. Oil, moisture, dirt and grease cause insulation breakdowns. Chafing or rubbing against unprotected edges soon wears away all insulation at that point. Temporary wiring is hazardous. Nuts and lock nuts should be tight. Defective wiring is an outstanding cause of electrical trouble and fires.

High temperature is a sure sign of trouble. However, one must be sure that the temperature is excessive. To touch an enclosure or coil or motor and decide it is too hot is not a safe procedure because safe operating temperatures are often higher than one can comfortably "feel" with the hand. The best procedure is to know what temperature is considered safe and then actually measure it.

Here are the high-points that should be checked to keep motor starters in good operating condition. They must be free of dirt and moisture. Air-insulated starters must be free of oil, and oil should be used on contacts or bearings of contactors and relays. Connections should be tight and wiring should be safe. Movable parts of contactors and relays must move freely and without friction. Contacts should be clean and tight with correct pressure and not worn too thin. Arc-rupturing devices must be in operating position. Keep available an adequate stock of replacement parts as recommended by the manufacturer of the equipment.

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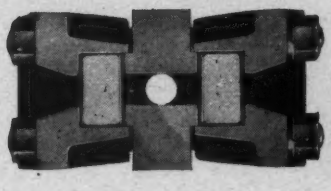

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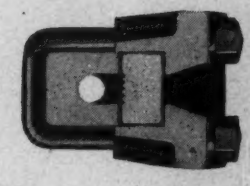

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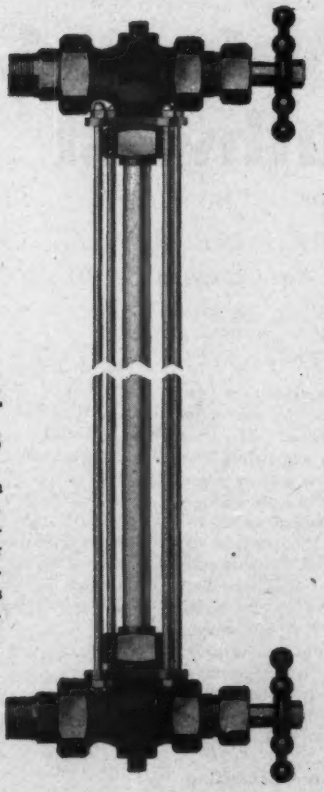

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Economic Factors Affecting the Utilization of Natural Gas In the Southwest

PART 1

CLINTON C. RANDALL* and R. L. HUNTINGTON
School of Chemical Engineering, University of Oklahoma

THE controversial question as to the proper utilization of natural gas from the large reserves of the Southwest is receiving considerable attention at present. This paper presents arguments pro and con in regard to both (1) increased sales to distant markets and (2) retention of gas for future use in the Southwest. After more study of cost data are made, the authors hope to be able to arrive at some definite conclusions; for the time being the reader is asked to draw his own conclusions based on the viewpoints discused, as seen by:

1. **The gas companies and royalty owners,**
2. **The natural gas producing states themselves,**
3. **The United States as a whole.**

THIS paper brings out some of the more important factors involved in the solution of the problem as to what program should be adopted for the most economic development of Mid-Continent and Gulf Coast natural-gas reserves. The proper utilization of these reserves, located principally in Texas, Kansas, Oklahoma and Louisiana, is one of great importance not only to these producing states but also to the economic welfare of the United States. Within this Southwest region is located the largest natural-gas reserve known to exist in the territorial United States.

At the present rate of production it is estimated that the gas reserve of these fields will last approximately 30 years The major problem at the present time calls for an answer to the following questions:

1. Should the volume of natural gas transported by pipe line to the industrial regions of the Middle West centered in Chicago and the East (Philadelphia being the center) be gradually increased in order to take care of the growing demands for high-quality fuel?

2. Should the sales to the Middle West and Eastern markets be reduced in order to hold the gas in reserve for the future industrial development in the Southwest?

As insufficient cost data are available to the authors at the present time, no attempt will be made in this paper to present a quantitative solution of this problem. The purpose of this paper, therefore, will be to give the reader a general idea of the problem by presenting the viewpoints of the several parties most concerned, namely,

1. The gas companies and royalty owners;

2. The natural gas producing states themselves;

3. The United States as a whole.

Since the gas companies have spent millions of dollars in the development of transportation systems to move this gas from the Texas and Oklahoma Panhandles, as well as Southwest Kansas, to the industrial centers of the Middle West, approximately 1000 miles distant, it is only natural that they should expect to receive a fair return on their investments. Before the construction of

* Present address, U. S. Navy Training Unit, Columbia University.

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gas pipe-line arteries, much of the residue gas from gasoline plants in the Southwest was being released to the atmosphere and wasted. One of the prime motives for this pipe-line development, therefore, was to conserve this natural resource by providing a more desirable fuel than coal for domestic use and certain industrial processes in large cities like Chicago, St. Louis, Detroit, and Minneapolis.

The cost per Btu of heat to these industrial companies for gas as compared with the cost per Btu for coal varies with the fluctuation of the coal market; but due to technological developments in the pipe-line industry, gas has been able to compete favorably with coal. Although coal can compete favorably with natural gas on a Btu basis, throughout the Middle West and East, the latter fuel is preferable especially for domestic cooking and for some industrial processes connected with steel manufacturing. Therefore, to a limited extent, the natural gas from the Mid-Continent and Gulf Coast fields can be sold at a profit to certain industries even at a higher cost per Btu than that of coal.

For the above reasons the gas companies will try to maintain their sales in the Northern and Eastern areas in order to protect their investments and increase their immediate profits. Whether further pipe lines would be profitable depends upon the increased demand for gas in these regions and the future costs of coal.

Many of the royalty owners are farmers and ranch men who have resided in this area for a number of years. They are glad to have the steady additional income resulting from the sale of this natural gas. Partial failures of crops throughout this dry plains region are quite frequent; hence this revenue from gas often makes it possible for some owners to tide themselves over certain dry periods where otherwise they might have to abandon their farms and ranches.

Due to the present shortage of tankers, large pipe lines such as the 20-inch products line and the 24-inch crude-oil line have been laid from Texas to the Eastern Seaboard for the transportation of gasoline and crude oil. When peace comes, water freight from the Gulf ports will probably make it uneconomical to continue the transportation of oil and gasoline through these lines. At such a time, however, these lines could be switched to gas. Whether such a plan is desirable is part of this problem. From the standpoint of the pipe-line owners and of the gas-field operators it may prove practical. If the "Big-Inch" lines are utilized in this manner, the investments in them would be protected and the markets for gas considerably increased. Such a transition, of course, will depend upon the cost of pumping gas to the Eastern areas and upon the relative demand of such markets as compared with local markets.

During the past few years there has been concerted promotion on the part of certain agencies in the Southwest to induce large industrial companies to locate in this region. The present war has aided this promotion and has been the cause of numerous plants locating in this region, notably plants of a chemical nature. Such a migration of industry to these areas will cause a marked increase in the local consumption of gas from the gas reserves. It is for this reason that these regions have considered the advisability of curtailing the sale of gas to the Northern industries and holding it in reserve for those companies which may locate in the Southwest. Thus cheap natural gas is held as an inducement for the location of such industries.

While it is true that fuel costs are a factor involved in the location of any industrial plant—it is also true that this factor is seldom the predominant one in the economics of such a location. Other factors such as markets, transportation and raw materials are of equal or greater importance in most instances. For chemical industries based on petroleum the Southwest offers a favorable location close to raw materials, and the Gulf Coast offers the additional advantages of favorable water transportation. In other industries, especially those involving iron and steel, the Southwest would not offer a favorable location in spite of cheap fuel costs. In general the Southwest is poor in natural resources of a commercial grade with the notable exception of petroleum, brine, natural gas and sulfur.

The future of the Southwest probably lies in the development of more tributary and complementary industries rather than basic industries; that is, industries which produce largely for local markets and can do so economically because of high freight differentials. The development of such industries would increase the local market for gas but probably this demand would not reach the proportion that the Northern markets have or will require. Hence, it appears that though it may not be advisable to increase the sale of gas to the Northern regions, it likewise would not be advisable to reduce such sales appreciably. A substantial part of the income from gas sales to Northern industries are paid to companies and royalty owners within the Southwest region and in the long run might contribute as much to the welfare of the region as would future industrial developments that may or may not take place.

Thus, it is seen that the regional interests are prone to take an optimistic view in regard to industrial development within the region and place undue emphasis on holding back the natural gas resources for uncertain future demands.

Looking at the problem from a nationwide point of view it does not seem to be sound economics to restrict the use of gas to the regions producing it. It would tend to produce an unnatural economic structure by causing industries which require gas either to move to areas which are otherwise not economically attractive or to revert to some other source of fuel.

From the broad economic viewpoint it is a recognized principle that regions should produce those things in which they have an economic advantage and import those goods which they cannot produce profitably. In this case the Southwest can produce gas economically and sell it at a profit in the North, and the North in turn has an economic advantage in manufactured goods and can sell them at a profit in the Southwest where they cannot be profitably produced. Such an exchange of goods is of mutual benefit and hence is to the general welfare of the nation.

The pretense of restricting further sales to the North as a conservation measure does not seem to be too sound. While it is true that conservation should be practiced, at the same time there is a difference between conservation for the benefit of the country as a whole and the restriction of gas sales to a small region. Conservation might be better achieved:

1. By the prevention of waste in the producing fields;
2. By limiting the use of gas to those industries in which it is essential or superior;
3. By switching from gas to other fuels in those industries in which gas is not essential.

One argument in favor of restricted sales of gas to the Northern and Eastern states is that they may produce gas from their extensive coal reserves (estimated life 3000 years) at a reasonable cost. However, the Southwest also has a secondary source of gas, namely the production of artificial gas by the cracking of heavy residues in petroleum refineries. Gas has been produced economically by this method. Both of these methods will undoubtedly be utilized to a greater extent when the gas reserves become less plentiful. In the meantime, it seems that the best interests of the country would be served by utilizing the available natural gas to the best advantage based on the current industrial and domestic needs of the country.

Major natural gas pipe lines from the Southwest to the East and Middle West and the emergency crude oil products lines recently constructed.

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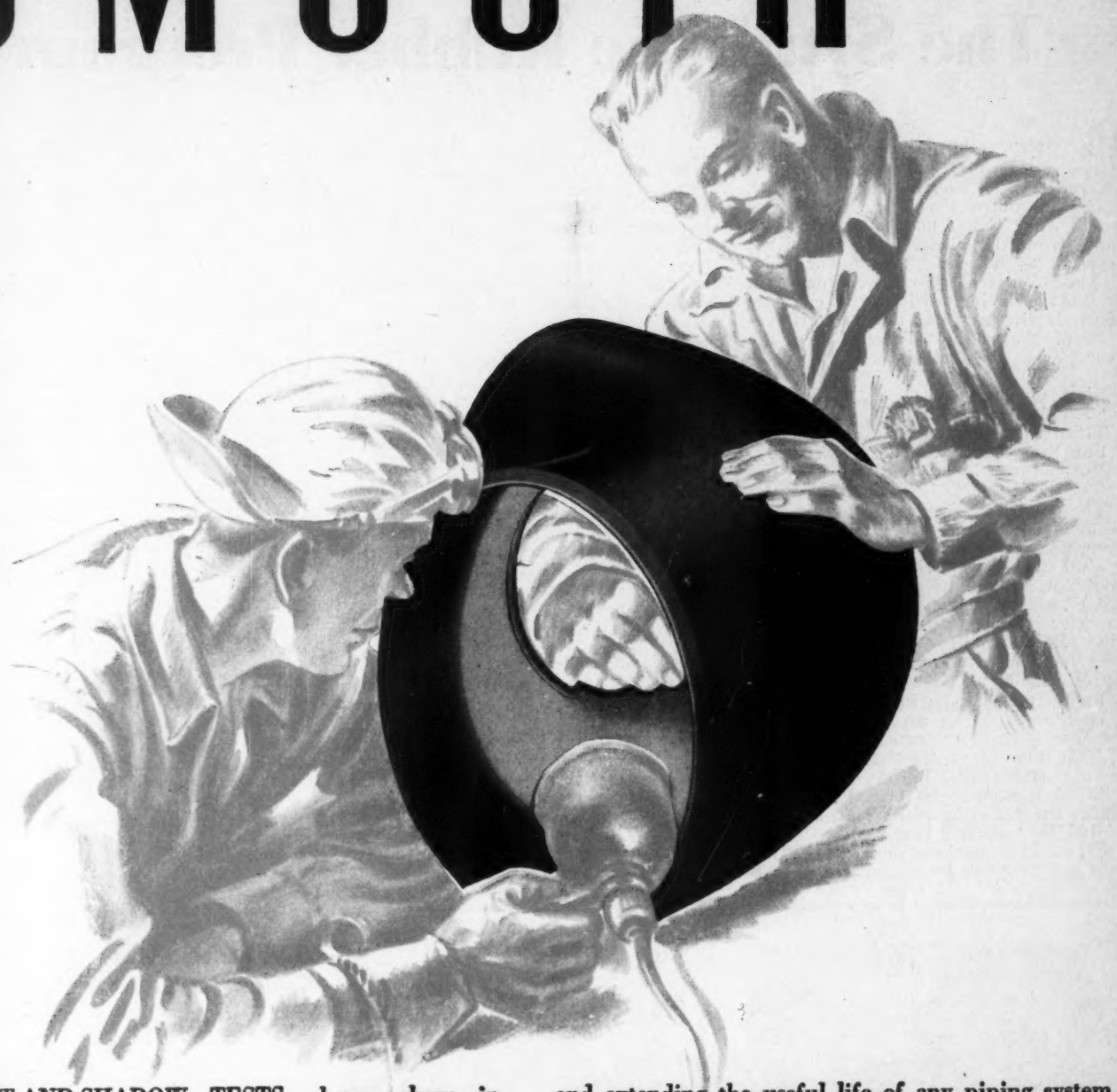

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Status of Petroleum Contribution to The Synthetic Rubber Program

PRODUCTION of synthetic rubber at the rate of 1,000,000 tons per year is assured for the fourth quarter of 1944. Such an output will include GR-S, Butyl, Buna N and neoprene and it will come from the plants built by private industry as well as those financed by Defense Plant Corporation. One plant in Canada is included in the estimate of production made in the quarterly report of the rubber director. For the year he set this schedule:

	Long Tons
First Quarter	166,500
Second Quarter	209,800
Third Quarter	235,800
Fourth Quarter	256,800
1944 Total	868,900

The plant-construction program will be finished around the middle of this year, giving the program the benefit of its full capacity for the final quarter. A study of sources of the ingredients of GR-S rubber shows that in designed capacity rating, petroleum will provide 458,500 tons per year, with 230,000 tons from alcohol, annual rated capacity of 688,400 tons.

Rated styrene capacity is 202,700 tons.

In the petroleum program 14 plants are complete with rated capacity of 272,900 tons per year; three plants are in the status of "initial operations," with rated capacity of 80,500 tons; two plants are building with rated capacity of 105,000 tons per year.

Plants in three locations with 220,000 tons per year rated capacity are operating on alcohol, while one of 10,000 tons capacity is under construction.

But the plants operating on alcohol are producing 160 percent of rated capacity, with the result that the supply of butadiene is well ahead of schedule, although the plant-construction program for making butadiene from petroleum fell behind schedule last year.

But plants operating on petroleum as a raw material also are producing well above rated capacity, some 25 percent higher than calculations and in one instance 35 percent higher than rated capacity. Indications are that the petroleum source will provide far greater than the rated capacity at the time of designing.

Since there is styrene output sufficient to matching 800,000 tons of butadiene per year and the higher output of butadiene plants can provide that amount, it will be possible by 1945 to produce GR-S (Buna-S) at the rate of 1,000,000 tons per year, leaving neoprene, butyl and Buna-N in excess of that figure.

Although the program now nearing the end of plant construction differs radically from early efforts, it is significant that the result in output is close to the recommendations of the Baruch committee, as explained by Colonel Bradley Dewey, rubber director, in his last quarterly report:

"It is now estimated that Buna-S (GR-S) will be made during the fourth quarter of the year at the rate of 900,000 tons per year and all synthetics at the rate of 1,027,000 long tons per year. These rates are remarkably close to the 875,000 and 1,074,000 long tons of the Baruch Committee. Improvements in the production rates, particularly of Butyl, which will be realized in 1945, should bring the potential ultimate capacity of the present plants up to the Baruch committee figure for the total program."

His report dealt extensively with the progress in tire making from GR-S rubber as well as the research now being done in both public and private laboratories. But he admitted the deficiency of this rubber casing purposes:

"But, even with all the above work under way, it is all too evident that there is one characteristic of Buna S which presents a major challenge to modern science. Despite its many good qualities, Buna S loses too much of its strength at elevated temperatures. Scientists must discover a modification of Buna S or a competitive polymer which when hot will do at least as well as crude rubber. There is some evidence that this can be done. A large part of the research effort of the future will be directed toward the solution of this problem."

This rubber will make an acceptable casing as indicated in the previous quarterly report. But the prospect for civilian tires for the remainder of the year is not bright. On this the report reads:

"Progress report No. 4 recorded that passenger-car tires made with cotton

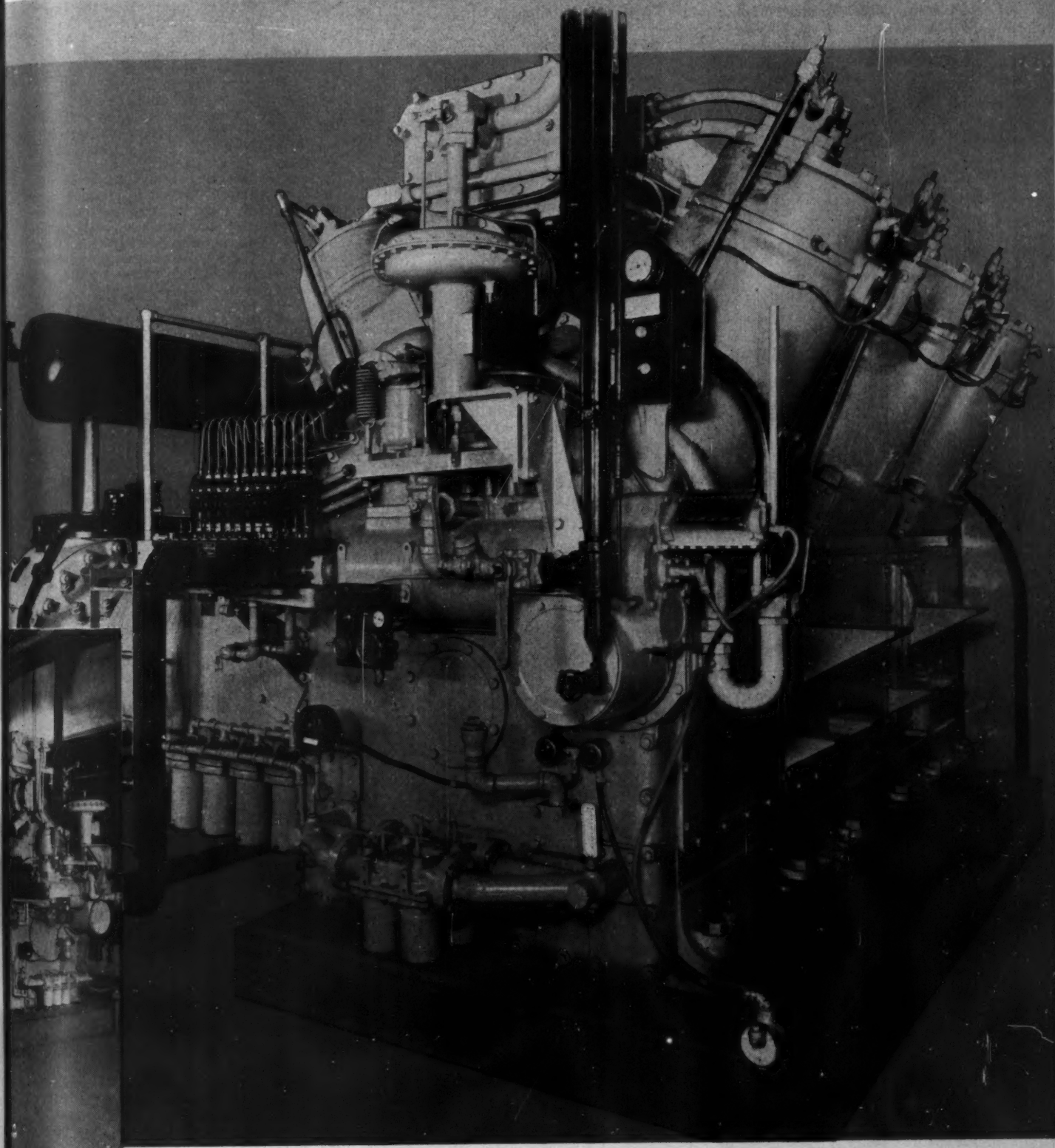
Members of the General Committee in charge of arrangements for the Southwestern Gas Measurement Short Course to be held at the University of Oklahoma, Norman, June 6-8. Front row (left to right): James L. Griffin, Northern Natural Gas Company, Omaha; Miss Kate A. Niblack, Oklahoma Utilities Association, Oklahoma City; W. H. Woods, Gulf Oil Corporation, Houston; Max K. Watson, Canadian River Gas Company, Amarillo; Earl Kightlinger, Arkansas Louisiana Gas Company, Shreveport; W. H. Carson, Dean, College of Engineering, University of Oklahoma; R. M. Scofield, Lone Star Gas Company, Dallas. Back Row (left to right): E. C. McAninch, Oklahoma Natural Gas Company, Tulsa; E. L. Stark, Foxboro Company, Dallas; George E. Greiner, Phillips Petroleum Company, Bartlesville; C. E. Terrell, Southern Natural Gas Company, Birmingham; Lloyd L. Jordan, Arkansas Oil and Gas Commission, Eldorado; W. R. McLaughlin, Pittsburgh Equitable Meter Company, Dallas; C. A. Gibson, Cities Service Gas Company, Bartlesville; L. B. Taylor, Kansas Corporation Commission, Wichita.

Gas Measurement Course in June

Plans for the 1944 Southwestern Gas Measurement Short Course to be held at the University of Oklahoma, Norman, June 6 to 8, were discussed at a recent meeting of the general committee at Oklahoma City. A tentative list of lecturers and instructors was made up and further arrangements of the program are under direction of Earl Kightlinger, chairman of the program committee. Activities of the practical methods committee will continue under the chairmanship of E. C. McAninch, and it was indicated by W. H. Woods, in charge of exhibits, that most of the manufacturers who have participated in the past are planning educational exhibits.

George E. Greiner, Phillips Petroleum Company, Bartlesville, was elected a member of the committee to succeed G. W. McCullough, and B. F. Worley, United Gas Corporation, Houston, succeeds R. J. Sullivan, resigned. Lloyd L. Jordan, Arkansas Oil and Gas Commission, and L. B. Taylor, Kansas Corporation Commission, also were elected to the committee.

the Rubber Problem



by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Houston, Dallas, Greggton, Pampa and Odessa, Texas Tulsa Shreveport St. Louis Los Angeles

Butadiene from Petroleum

Company and Plant Location	Rated Annual Capacity in Tons	Status March 15, 1944	
Carbide & Carbon Chemicals Corporation.. South Charleston, West Virginia	5,000	Complete	
Cities Service Refining Corporation..... Lake Charles, Louisiana	55,000	Building	
Dow Chemical Company..... Midland, Michigan	1,200	Complete	
Humble Oil & Refining Company..... Baytown, Texas	30,000	Complete	
Humble Oil & Refining Company..... Ingleside, Texas	7,000	Complete	
Lion Oil Refining Company..... El Dorado, Arkansas	6,700	Complete	
Neches Butane Products Company..... Port Neches, Texas	100,000	Half of Plant Complete	
Phillips Petroleum Company..... Borger, Texas	45,500	Complete	
Shell Chemical Company..... Torrance, California	25,000	Initial Operations	
Shell Oil Company..... Houston, Texas	6,000	Complete	
Sinclair Rubber, Inc..... Houston, Texas	50,000	Initial Operations	
Southern California Gas Company..... Los Angeles, California	30,000	Complete	
Standard Oil Company of California..... El Segundo, California	15,000	Complete	
Standard Oil Company of Louisiana..... Baton Rouge, Louisiana	31,000	Complete	
Sun Oil Company..... Toledo, Ohio	15,000	Complete	
Taylor Refining Company..... Corpus Christi, Texas	5,500	Initial Operations	
Ugite Sales Company..... Chester, Pennsylvania	500	Complete	
Polymer Corporation..... Sarnia, Ontario	30,000	Complete	
Total butadiene from petroleum.....	.....	.....	458,400 tons

Butadiene from Alcohol

Carbide & Carbon Chemicals Corporation.. Institute, West Virginia	80,000	Complete	
Carbide & Carbon Chemicals Corporation.. Louisville, Kentucky	60,000	Complete	
Koppers United Company..... Kobuta, Pennsylvania	80,000	Complete	
Publicker Commercial Alcohol Corporation Philadelphia, Pennsylvania	10,000	Building	
Total butadiene from alcohol.....	.....	.....	230,000 tons
Total butadiene capacity.....	.....	.....	688,400 tons

Styrene Production

Carbide & Carbon Chemicals Corporation.. Institute, West Virginia	25,000	Complete	
Dow Chemical Company..... Los Angeles, California	25,000	Complete	
Dow Chemical Company..... Midland, Michigan	4,200	Complete	
Dow Chemical Company..... Velasco, Texas	50,000	Complete	
Koppers United Corporation..... Kobuta, Pennsylvania	37,500	Complete	
Monsanta Chemical Company..... Texas City, Texas	51,000	Complete	
Dow Chemical Company of Canada..... Sarnia, Ontario	10,000	Complete	
Total styrene capacity.....	.....	.....	202,700 tons

cord and 100 percent Buna S are eminently satisfactory and of high quality. Since then further testing has confirmed this. However, the wear and tear incident to any driving and the casualties resulting from normal use are gradually bringing about a situation which will inevitably result in more suffering to the careless driver who forgets the effect of speed upon the life of his tires and the decreased life that results when any tire, whether made of synthetic or crude rubber, is run underinflated and damaged by hitting holes in the road, run on improperly aligned wheels or otherwise abused.

"In the last progress report it was felt that the result of normal attrition would call for the building in 1944 of 30,000,000 new passenger-car tires. Based on present conditions it is now believed that 22,000,000 passenger tires will be sufficient for essential driving. However, the driving 'as usual' or indifference to making tires last as long as possible would endanger civilian transportation. Only the public can make its tires last. We can not. We count on the public. The present production plan contemplates making 22,000,000, 15,000,000 of which will be produced in the last half of the year. Meeting this goal will not be easy. This total will be plus or minus 10 percent, depending upon the trend of military requirements throughout the balance of the year."

Philblack Division Opens Sales Office

Frank Andrews has been appointed sales manager of Philblack Division of Phillips Petroleum Company. He has been with Phillips Petroleum Company for the past 15 years, and since 1940 has been sales manager of Hycar Chemical Company, an affiliate of Phillips Petroleum Company and The B. F. Goodrich Company.

Phillips Petroleum Company has for many years been closely associated with the carbon-black industry, not only as a supplier of natural gas used, but also in cooperative manufacturing with other companies. The company has carried on intensive research for improved methods of manufacture and the development of new products. As a result of this work a new type of furnace black called Philblack, was developed and a plant for its manufacture is now starting production. Philblack was designed primarily for synthetic rubber. An office is being established in Akron, Ohio, for the purpose of handling the sale of this new material.

Andrews will, for the present, continue his association as sales manager of Hycar Chemical Company.

South American Liquid Fuels Conference Canceled

The First South American Conference on Liquid Fuels which was to have been held in Buenos Aires, Argentina, in April, has been postponed indefinitely inasmuch as the Argentine Section of the Instituto Sudamericano del Petroleo has decided that "it is impossible to gather, under the present circumstances, all the success elements required." The executive committee has decided to submit the matter to the consideration of the International Permanent Council of the Instituto, at a meeting in Montevideo, April 10-13.

Western Refiners Discuss Plans for Getting Idle Capacity on Stream

Plans for increasing the throughput of refining plants of the Middle West held a foremost part in the one-day annual meeting of the Western Petroleum Refiners Association in St. Louis, March 28. This area has 200,000 barrels of idle capacity because of insufficient charging stock. Through efforts of the industry, PWA and ODT a program is being worked out for providing additional crude oil from West Texas and possibly Wyoming.

All officials of the association were reelected: C. L. Henderson, Vickers Petroleum Company, Wichita, president; and the following vice presidents: R. W. McDowell, Mid-Continent Petroleum Corporation, Tulsa; C. W. Cahoon, Jr., Olney Oil & Refining Company, Wichita Falls; T. M. Martin, Lion Oil Refining Company, El Dorado, Arkansas, and H. E. Zoller, Derby Oil Company, Wichita.

Speakers were C. L. Henderson, who gave his annual report; W. W. Vandeveer, director of district 2 PAW; Bruce K. Brown, assistant deputy administrator, PAW; Paul Ryan, chairman of the post-war readjustment committee of PIWC, and Commander P. G. Winston, USN.

Henderson cited the shortage of 200,000 barrels daily in charging stock for plants in the Middle West and placed part of the blame on agencies of government, saying:

"The shortage could have been alleviated, possibly eliminated, if government officials had relied more heavily on the sound advice of experienced oil producers. Such advice would have resulted in the authorization of a reasonable advance in the price of crude oil and an accompanying increase in the price of refined products . . . "

He expressed objection to the subsidization of the industry with federal funds and suggested restoration of the law of supply and demand as a solution of the shortage of raw materials for refining.

Vandeveer estimated total production of crude oil in the United States for 1944 at 1,620,000,000 barrels, with an indicated demand for 1,800,000,000 barrels. His prediction was that the supply situation would not be solved soon.

For the Middle West, however, he promised early supplies of crude oil from West Texas by tank-car delivery. His discussion of this possibility was accompanied with the request that refiners of the area prepare to use this crude oil as part of their charging stock. He mentioned the known doubt that exists and the fear that it will be destructive of equipment because of high sulphur content. In other areas, however, he pointed out that these and similar crudes have been used over a long period and suggested that refiners in the Middle West learn how to use the sulphur-bearing crude effectively, since it offers the only immediate solution to the raw material supply problem.

Bruce K. Brown spoke informally of the prospects for 100-octane gasoline, whose output he predicted would increase by one third within the next 60 days. He made one point clear, concerning the future supply. His opinion is that there will never be a surplus of high-octane aviation motor fuel, for the reason that its specifications will change as soon as there is a surplus and that each improvement in specifications will result in reduced output. His prediction is that successive improvements in quality will keep pace with the increased output of plants.

In discussing the proposed government-financed pipe line in Arabia, Paul Ryan pointed out that it will meet the competition of tanker transportation through the Suez canal, whose management can reduce its tolls and thus make tanker transportation more attractive. He further warned that the proposed line will be useful only to the extent that the Mediterranean is kept in control and further that the line will traverse the territory of eight Shiekdoms, whose rulers are versed in methods of gaining frequent monetary contributions by methods long prevalent in the Near East. He advised the industry to assert itself, saying:

"It is up to the oil industry to decide when the time is right to build a pipe line and that time must be determined in terms of markets which do not exist at present. If any action is to be taken by oil men, they should urge Congress to cancel the contracts made by Petroleum Reserves Corporation with three oil companies to purchase the oil they could supply from the Middle East."

Commander Winston discussed the selective service system from the military viewpoint.

National Petroleum Body Cancels April Meeting

National Petroleum Association has announced cancellation of its scheduled meeting at Cleveland in April and officers have suggested instead that regional conferences be held because of the transportation situation. Plans are going forward for the annual meeting of the association at Atlantic City, Hotel Claridge, September 20-22.

Mid-West Plants Asked To Increase Fuel Output

W. A. Vandaveer, director, District 2, PAW, has requested Midwest refiners to step up production of diesel oil for military purposes, soliciting compliance with a plan worked out by the industry committees for equitable proration of this urgently needed by-product. Although the request came in the form of a suggestion rather than a directive manufacturers are accepting the request as an order.

In submitting the request to refiners in Oklahoma, Kansas, Nebraska, Missouri, Illinois, Indiana, Wisconsin, Kentucky, Ohio, Tennessee and Michigan, Vandaveer observed that under the proration plan the entire amount of 702 Navy Diesel fuel to be furnished will be apportioned among refiners producing this product. Other refiners are being asked to make available replacement products such as kerosine, range oil and distillate fuels in a quantity covering their pro-rate of volume.

Vandaveer placed no time limit on the operation of the plan but indicated the increased demand to meet the immediate requirements of the navy will be temporary.

Synthetic Fuel Measure Is Sent to White House

Legislation authorizing the Interior Department to initiate a $30,000,000 investigation of the possibilities of producing synthetic fuels from coal, shale and other substances, was agreed to by the House and Senate March 28 and sent to the White House for approval.

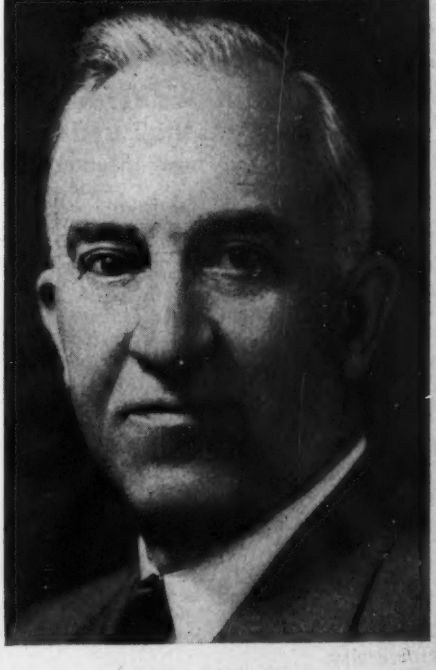
The measure as finally passed provides for an investigation of the fuel possibilities of agricultural and forestry products, to be undertaken by the Department of Agriculture, and says that, in conducting research and development work, the Interior Department is authorized, with pilot and semi-works plants, to make engineering studies in order to ascertain lowest costs.

The Secretary of the Interior is authorized to acquire patent and other rights.

The secretary is authorized to grant licenses under patent rights acquired under the act, with a provision that he shall make available to the citizens and corporations of the United States the use of any inventions, discoveries or processes which may be developed in operations under the act as well as those covered by patents which he may acquire. This latter privilege, however, will not apply with respect to patents which are used by the government under license only.

Asphalt Institute Sets Up Regional System

F. V. Widger, manager of asphalt sales for The Texas Company, New York, has been elected chairman of the executive committee of the Asphalt Institute, whose directors have set up a regional system for its functioning



F. V. WIDGER

and elected the following five vice presidents for the districts:

F. R. Field, Standard Oil Company of New Jersey, Atlantic Seaboard-Southern; A. M. Maxwell, Standard Oil Company of Ohio, Ohio-Great Lakes; H. B. Pullar, Berry Asphalt Company, Mid-West; D. D. Williamson, Talco Asphalt & Refining division of Southport Petroleum Company, Gulf; H. R. Pauley, The Petrol Corporation, Pacific Coast.

The five vice presidents also are members of the executive committee.

Bernard E. Gray was reelected general manager and chief engineer and Herbert Spencer was reelected president. George R. Christie was reelected treasurer and John N. Smith was continued as assistant treasurer.

Asphalt producing companies recently elected to membership are: The Derby Oil Company, Wichita; Lion Oil Refining Company, El Dorado, Arkansas; Skelly Oil Company, Tulsa. Membership is now 38, highest in the history of the institute.

Further Cut in Civilian Driving Said Possible

Having "backed into" gasoline rationing, in the East because of the transportation situation and in the rest of the country as a means of saving rubber, OPA now is having difficulty convincing the public that rationing is necessary because of a shortage of the gasoline itself, it was admitted last week by Deputy Price Administrator Bryan Houston.

Houston warned of possible cuts in some categories of civilian driving may be necessary within the next few months, if black markets and non-essential consumption are not controlled, because of the limited additional supplies now foreseen to take care of the seasonal agricultural demand.

For the second quarter of this year, he said, the available supply will be not quite 13 percent more than for the first quarter, whereas last year there was 18 percent more motor fuel for the second quarter. At the same time, he said, consumption for the first quarter this year ran slightly above quota.

Establish Heat Transfer Study Program at Purdue

A joint industry-education enterprise has been established at Purdue University for "intensive training of graduate students in exploring the field of heat transfer for data upon which many of the practical developments of the future depend." Made possible by a $75,000 grant from Westinghouse Electric and Manufacturing Company, the five-year training and research program will be directed by Dr. George A. Hawkins of the Purdue faculty, who has been appointed Westinghouse research professor in heat transfer. Dr. Max Jakob of the Illinois Institute of Technology will cooperate as non-resident research professor, and research associates will be selected by Dr. Hawkins. The group will have access to the heat-transfer laboratory of the School of Mechanical and Aeronautical Engineering on the Purdue campus as well as facilities of other departments of the university.

Aviation Gasoline and Toluene Production Figures Released First Time by Committee

Members of the Petroleum Industry War Council, at their April meeting, were told of the Army and Navy's need for the Saudi Arabian pipe line but after a one and one half hour exposition reportedly had not changed their mind as to the desirability of the much-controverted Petroleum Reserves Corporation project.

With little of importance before it for discussion, PIWC also heard Colonel Bryan Houston, OPA deputy administrator for rationing, and members of his staff, who discussed the rationing problem and gave a demonstration of black-market operations.

The monthly report of the committee on petroleum economics was confined to a discussion of trends in the oil industry since 1918, showing that currently "we have the remarkable situation at a time of peak demand and abnormally low discovery rate, where petroleum prices are only about 60 percent of the general commodity index."

Gasoline Output

The report for the first time disclosed production of all grades of aviation gasoline and toluene, showing that in 1941, total output was 19,000,000 barrels, or an average of 52,000 barrels daily, jumping to 48,000,000 barrels, or 132,000 barrels daily, in 1942, and last year to 101,000,000 barrels or 277,000 barrels daily, an increase of 430 percent over 1941.

For 1944, it was estimated, output will rise to 196,000,000 barrels, or 536,000 barrels a day, an increase of 930 percent over 1941.

The report placed estimated production of crude oil for 1944 at 1,601,250,000 barrels, or 4,375,000 barrels daily, an increase of 98,000,000 barrels over 1943. Production of motor fuel will be 725,000,000 barrels, of which 629,000,000 barrels will be gasoline from crude, the latter representing an increase of nearly 98,000,000 barrels over 1943, other production including 81,250,000 barrels of kerosine against 72,270,000 barrels last year; 679,660,000 barrels of distillate and heavy fuel oils against 628,822,000 barrels, and 102,000,000 barrels of natural gasoline and allied products against 88,179,000 barrels.

Total domestic and export requirements this year will call for 1,825,242,000 barrels against 1,670,605,000 barrels last year.

To Fight Black Market

As a result of Colonel Houston's showing of black market operations, the Council appointed an 11-man committee, headed by B. L. Majewski, chairman of the Marketing Committee, to undertake an extensive educational campaign within the industry against outlaw practices.

The committee will be composed of the chairmen of the five PIWC district marketing committees and the five district subcommittees on Products Conservation, and B. I. Graves, chairman of the Committee on Products Conservation.

"The oil industry is not in any way responsible for the present gasoline rationing system or the enforcement of the same," PIWC Chairman William R. Boyd, Jr., explained. "Nevertheless, the existence of a 'black market' constitutes a serious threat to the civilian transportation system and gasoline rationing program. If not curtailed it will result in inequities to the consuming public who are complying with the present regulations and will also be a reflection on the oil industry which has contributed so much to the war effort."

Procedure for Deferment Of Essential Personnel

The Petroleum Administration for War has been designated as the agency for endorsing special requests for deferment of essential technical men in the aviation-gasoline program. The following procedure was prepared by Bruce K. Brown, assistant deputy administrator, PAW, who has advised that it can give no consideration to any request until the following procedure has been met:

"(1) Prepare and file three copies of SS Form 42-A (Special) directly with the Office of the Labor Counselor PAW, 6640 Interior Building, Washington, D. C., **setting forth in detail** the nature of the occupation, qualifications, irreplaceability, etc. of each registrant.

"(2) Submit also to the Labor Counselor a "company certification" applying to all men for whom 42-A (Specials) are submitted which must be signed by an officer of the company who will assume personal responsibility for the statements contained therein. Note the criteria for certification below.

"(3) If a replacement schedule and summary for the plant have been filed with the State Headquarters of Selective Service, a copy of such replacement schedule and summary must be sent to the Office of the Labor Counselor if not previously sent.

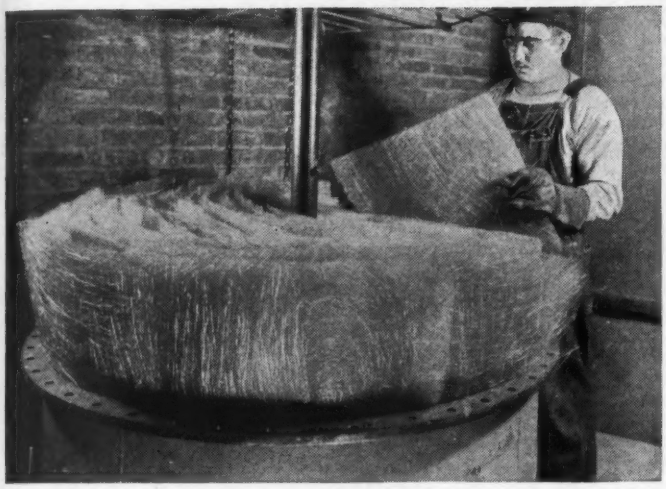
"Men under 26 are being reclassified daily. This Administration cannot act on any case until the steps above are complied with. Your ability to retain key men will depend in part on the speed with which you take action on the steps outlined above.

"All men under 26 will be given preinduction physical examinations immediately. Inform these men that notice of such examination does not in any way imply that induction is thereby ordered.

Criteria for Certification

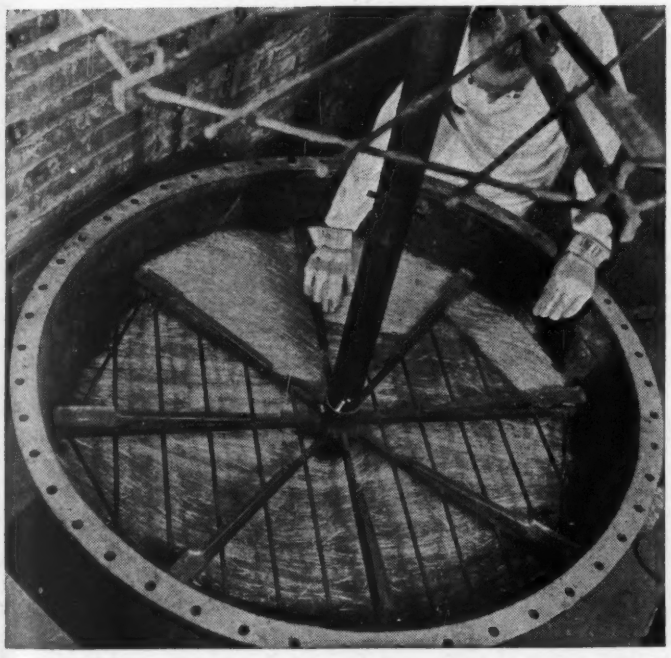
"Complete certification signed by an officer of the company for which he assumes personal responsibility that: All men under 26 for whom deferments are requested are engaged at least 48 hours per week in the 100-octane gasoline program and that such employees must possess such skill or educational qualifications to perform their jobs and that such workers cannot be replaced by men or women presently engaged on non-vital programs who are not im-

Why Fiberglas* tower packing helps double alcohol production



Fiberglas Tower Packing provides maximum surface per unit of volume . . . light in weight . . . easy to install.

Fiberglas Tower Packing can be installed up to 70% faster than other materials used for this purpose.



WITH FIBERGLAS* TOWER PACKING, distillery engineers can now build rectifying columns which will convert high wines to 191.5 proof alcohol . . . in approximately half the time formerly required.

Here's the story:

As most distilling engineers know, an important factor in determining the rate of distillation in a rectifying column is the amount of surface area presented.

Fiberglas Tower Packing is composed of relatively coarse glass fibers averaging .0080" in diameter. And these fibers present 135 sq. ft. of exposed surface area per cu. ft. of packing. In addition, the free volume is 2½ times that afforded by other packing materials.

Results have shown that a Fiberglas-packed column will handle more than twice the vaporization of a conventional plate column of the same diameter.

Now, add five more plusses . . .

1. Weighing only 3½ lbs. per cu. ft., this lighter-weight packing makes costly foundations and supports for towers unnecessary.
2. The percentage of volume of Fiberglas, packed at its normal density of 3½ lbs. per cu. ft., is only 2.25%. This means that the free volume is 97.75%.
3. First cost of Fiberglas Tower Packing is so low that it is cheaper to replace with new packing than to clean and re-use the old.
4. Because this lighter tower packing comes in larger, easier-to-handle units, it can be installed about 70% faster than materials formerly used. *Hours of shut-down time are thus saved!*
5. Being pure glass, this new-type tower packing involves no critical materials. It is available now for immediate shipment in quantity.

If your problems concern rectification, fractionation, or absorption, write us for further information about Fiberglas Tower Packing...*Owens-Corning Fiberglas Corporation, Toledo 1, Ohio. In Canada, Fiberglas Canada, Ltd., Oshawa, Ontario.*

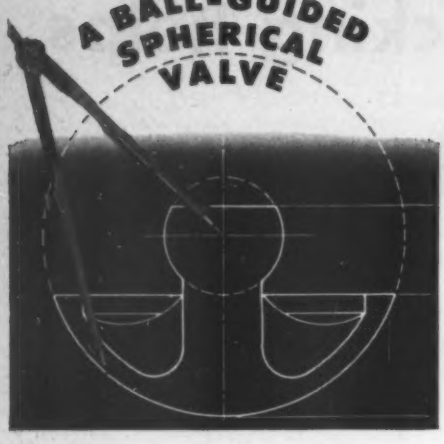
Design Engineers NOTE: *Patent has been applied for the particular column design illustrated by Hiram Walker & Sons, Peoria, Illinois. Installation at Tom Moore Distilleries, Inc., Bardstown, Kentucky . . . However, Fiberglas Tower Packing is readily adaptable to any packed column design.*

FIBERGLAS*

*T. M. Reg. U. S. Pat. Off.

TOWER PACKING

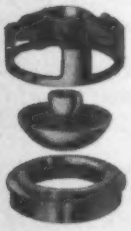
ARMY E NAVY



...FOR FRICTIONLESS OPERATION AND INCREASED VOLUME

Royal Crown **PUMP VALVES** increase the volume of most pumps. Why? Because every size of R C Valve is individually designed—no standard sized cage is used on two or three models for economy of manufacturing. Each seat, each valve and cage is graded in size for the highest efficiency—the throat of the seat is as large as practical.

With the frictionless ball stem, the valve is not retarded in action; it cannot bind in any position. The valve surface is stream-lined in effect to the flow of the liquid. There are no ring guides or crossbars to cause turbulence or to restrict the flow.



A complete range of sizes for either thread- or press-fit is available in any alloy metal. Write for catalog or see your dealer.

Howard Supply Co., Calif.
L. B. Stanley, Houston, Texas

MADSEN IRON WORKS
HUNTINGTON PARK, CALIFORNIA

mediately vulnerable to the draft or cannot be replaced by recruitment.

"As a basis for determining whether a man less than 26 years of age meets the criteria established in connection with the vital war program, the following tentative scope of activities is presented:

"**Technically trained personnel** (those holding College or University degrees in Science or Engineering), or the equivalent as defined by the WMC List of Critical Occupations, **vital** to the war program of the Petroleum Administration for War are those actually engaged in work employing to the highest degree possible their technical training in occupations contributing directly to the furtherance of the vital war program. In the case of research and development, the **vital** occupations of such technical people include at this time only the following activities:

"(1) Process Engineering, Technical Service and Technical Control (including pilot plant) to operations of processes for the current production of 100-octane aviation gasoline or synthetic rubber raw materials, or any components therefor.

"(2) Development work on processes which the Petroleum Administration for War, the Armed Forces, the Office of the Rubber Director or Rubber Reserve Corporation have reason to believe will lead to direct improvements in quality or quantity of current production of 100 octane aviation gasoline or synthetic rubber components.

"(3) Development work on any petroleum **product** directly leading to necessary improvements in quality of current production of aviation gasoline and synthetic rubber components."

Refineries Said Suitable For Postwar Utilization

PAW officials predict that practically all of the more than a half-billion dollars expended by the oil industry on 100-octane gasoline plants will be convertible to peace-time use after the war, in contrast with many other emergency construction programs, the postwar fate of which currently is one of Washington's major problems.

A total of $760,000,000 has been expended for new aviation gasoline facilities since Pearl Harbor, $550,000,000 of it by the oil companies, which will own outright 82 percent of the ultimate capacity of the plants. The remaining $210,000,000 was invested by the government, three fourths of it on equipment for small refineries.

Because of the flexibility of modern refining equipment, Administrator Ickes pointed out, the industry will not be faced with the alternative of continuing to turn out high-octane aviation gasoline in wartime quantities or abandoning its huge investment altogether.

"For one thing," he said, "expansion in both commercial and private flying is expected to provide a continuing market for considerable quantities of aviation fuel. For another, many of the new catalytic cracking units that have been built as part of the war program can be converted to peace-time use to increase both the quantity and kuality of postwar motor gasoline. To a certain extent, the same can be said of facilities for producing various types of blending agents used in 100-octane fuel."

Sixty-five percent of the increase in output attained during the first two years after Pearl Harbor came from the conversion of prewar catalytic cracking equipment, employment of new types of blending agents, increases in tetraethyl lead content and technological improvements in refineries, accomplished entirely without government financing.

Still Runs at Peak; Higher Gasoline Yield in January

Crude oil run to stills by refineries in the United States established a new record in January at 4,296,000 barrels daily, according to official figures of the United States Bureau of Mines. This was an increase of 36,000 barrels daily over December. Total demand for motor fuel was about 35 percent greater than in January, 1943. The gasoline yield rose to 38.6 percent, showing a 2.1 percent gain over the same month last year, and stocks of finished gasoline increased 5,526,000 barrels to a total of 70,490,000 barrels on January 31, but were about 8,000,000 barrels under those of the same date in 1943.

"In view of the rapidly expanding war demands for motor fuel, total demands in 1944 may well exceed all previous records," the bureau commented.

Crude oil production averaged 4,380,000 barrels a day during January, 20,000 barrels above December and 598,000 barrels, or almost 16 percent, over January, 1943.

Daily average demand for domestic crude set a new record at 4,417,200 barrels, a gain of 56,700 barrels over December, and to meet this demand crude stocks of domestic origin were reduced at the rate of 37,600 barrels daily, the bureau reported. Total stocks of foreign and domestic crude at the close of January were 248,097,000 barrels, compared with 249,404,000 barrels December 31.

The bureau's monthly "balance sheet" showed total output of domestic crude at 135,767,000 barrels in January against 135,152,000 barrels in December, and natural gasoline and benzol at 8,021,000 barrels against 7,998,000 barrels, a total production of 143,788,000 barrels against 143,150,000 barrels.

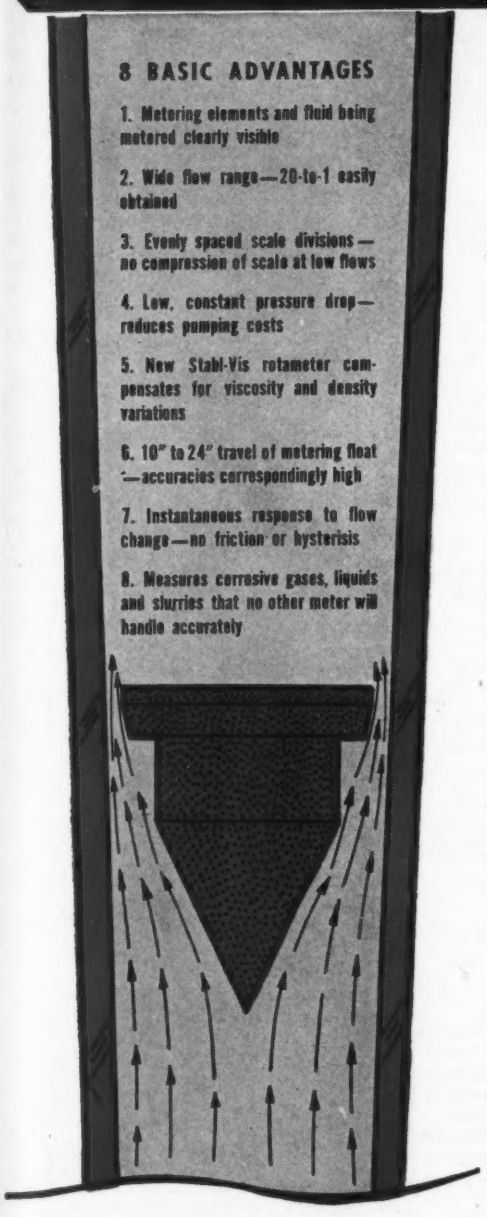
Stocks at the close of the month included 241,245,000 barrels of gasoline-bearing crude against 242,132,000 barrels December 31; 6,852,000 barrels of heavy crude in California against 7,272,000 barrels; 4,296,000 barrels of natural gasoline against 4,541,000 barrels, and 227,324,000 barrels of refined products against 229,362,000 barrels, a total, all oils of 479,717,000 barrels against 483,307,000 barrels.

Refinery Completed In Arctic Russia

London sources report that the Russian government has completed construction of a petroleum refinery at Ust-Ukhta, on the Izhma River, and that the new plant has a capacity of more than 30 million barrels per year. It has also been confirmed that a new railroad line, 1100 miles in length, has been completed and put into service across this far northern region, with its terminal at Khabarova, at the tip of the Paikhoi Peninsula, most northern point in European Russia. This new line provides an outlet for mineral deposits being opened in the northern Urals and coal and oil resources known to be present in the Pechora basin, which lies between the Urals and the Timan Mountains.

The ROTAMETER

has these advantages over head-type meters for flow rate measurement and control


8 BASIC ADVANTAGES
1. Metering elements and fluid being metered clearly visible
2. Wide flow range—20-to-1 easily obtained
3. Evenly spaced scale divisions—no compression of scale at low flows
4. Low, constant pressure drop—reduces pumping costs
5. New Stabl-Vis rotameter compensates for viscosity and density variations
6. 10" to 24" travel of metering float—accuracies correspondingly high
7. Instantaneous response to flow change—no friction or hysterisis
8. Measures corrosive gases, liquids and slurries that no other meter will handle accurately

DURING the last two years a definite reversal of trend in the development of meters for rate of flow measurement has become noticeable in industry. The area-type flow meter, in the form of the rotameter sight flow meter, has steadily and surely elbowed its way to the front. Already it has completely replaced the head-type meters (orifices, flow nozzles, venturis, weirs, capillaries) for many important applications and the process of replacement is still going on.

The inherent theoretical advantages of the area-type flow meter have always been recognized, and equally obvious were the several limitations of the head-type meter. Yet for a long time the area-type meter was mainly a curiosity, used only for unusually difficult applications. Not until Fischer & Porter Company in 1937 announced the availability of precision-bore, interchangeable transparent metering tubes for rotameter sight flow meters, did the area meter start to progress.

In Toricelli's equation $Q = CA\sqrt{2gh}$, the area-type meter (rotameter) obtains measurement by varying the value of "A" (area of flow passage) whereas head meters vary the value of "h" (head producing flow). Thus the rotameter "gets out from under the square-root sign," which results in a linear calibration scale instead of a square root scale crowded at the lower end. The range of flows which can be accurately metered with the rotameter is thereby tremendously increased.

Furthermore, the visibility in the rotameter of the fluid being metered and of the metering elements eliminates errors due to fouling or corrosion. Likewise, the pressure drop through the rotameter is low and constant because the flow area enlarges as the float rises in the tapered tube with flow increase. Thus the rotameter may be used where low initial pressures only are available, and at all times the rotameter reduces the pressure required to pump fluids through the lines. In remote recording and controlling rotameters, another outstanding advantage is the ability to visually check the readings of the primary instrument against the readings of the secondary instrument while in operation.

Possibly you have used the rotameter sparingly, or not at all, because you have not realized its basic worth. The further one delves into the details of the rotameter functioning, the more advantages come to light. Modern instrumentation is characterized by an acknowledgment of these advantages through the increasing use of the rotameter for flow rate measurement and control. Our bulletin #10-B entitled "A New Era in Flow Rate Measurement" describes the rotameter clearly and concisely. It contains free, valuable information — why not write for it? We will gladly send it to you without any obligation whatsoever.

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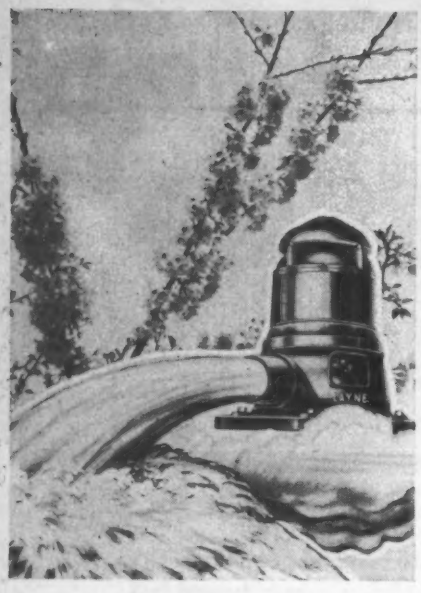
FLOW RATE INDICATING, RECORDING OR CONTROLLING ROTAMETERS FOR ANY LIQUID OR GAS



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Layne, as a pioneer in water development service, has encountered—and solved, perhaps a hundred times more problems than was ever faced by their nearest competitor.

For postwar days, many new well water systems will be needed. They must possess three important features: long life construction, high volume production, and economical operation. Layne Water Systems have always been outstanding in those very attributes.

Layne is now offering engineering guidance on postwar Water System construction plans. This service is obtainable without obligation. Now is the time to present your water supply problems. Literature on Layne Wells and Pumps may be obtained by addressing LAYNE & BOWLER, INC., General Offices, Memphis 8, Tennessee.

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BUILDERS OF WELL WATER SYSTEMS FOR INDUSTRIES AND MUNICIPALITIES

DIGEST OF UNITED STATES PATENTS

On Dehydrogenation and Dehydrohalogenation of Hydrocarbons

Compiled by HEINZ HEINEMANN

U.S.P 2,273,338. Production of Catalytic Material. C. L. Thomas to Universal Oil Products Company.

Supports for dehydrogenation catalysts are prepared by precipitating hydrated aluminum oxide from a mixture of solutions of sodium aluminate and ammonium chloride, filtering, washing with water to remove water-soluble impurities, drying, forming into particles and calcining at a temperature of the order of 300 to 500° C. Active formed particles of aluminum oxide are produced which are suitable for use as a carrier and may be impregnated with metals or metal oxides.

U.S.P. 2,274,204. Process for Selective Oxidation or Dehydrogenation of Petroleum Hydrocarbons. H. B. Kipper.

Hydrocarbon gases of more than one C-atom per molecule are dehydrogenated by mixing them with oxygen and an inert gas. The percentage of oxygen in the mixture should be less than 20, only sufficient oxygen being present to react substantially with all of the hydrogen liberated during the reaction. The mixture is contacted at superatmospheric pressure and temperatures between 100 and 400°C with a catalyst consisting of a combination of the oxides and hydroxides of iron and copper.

U.S.P. 2,283,854. Conversion of Hydrocarbon Oils. B. S. Friedman and W. L. Benedict.

A conversion process is described which includes a step in which a naphthenic oil boiling above about 200°F. is treated with a dehydrogenation catalyst under aromatization conditions. Suitable catalysts consist of a composite of a major proportion of a refractory carrier and a relatively smaller proportion of an element of the group consisting of titanium, zirconium, cerium, hafnium, thorium, vanadium, cobalt, tantalum, chromium, molybdenum, tungsten and uranium.

U.S.P. 2,288,580. Production of Unsaturated Compounds. H. Baehr and W. Deiters.

A hydrogen halide such as hydrogen chloride is added as a diluent to a vaporous halogen hydrocarbon, such as dichloro-butane, containing the halogen combined with non-aromatic C-atoms and the mixture thus formed is exposed to high temperatures (suitably about 550°C) under substantially anhydrous conditions.

U.S.P. 2,291,581. Process for the Treatment of Hydrocarbons. W. A. Schulze to Phillips Petroleum Company.

Bauxite impregnated with chromium oxide is an extremely effective catalytic material for dehydrogenating hydrocarbons and for a simultaneous conversion of organic sulphur compounds to hydrogen sulfide. Chromium salt in a rather concentrated solution is sprayed as a mist onto dehydrated bauxite which completely adsorbs the solution and immediately appears dry. The chromium salt is then converted to oxide by one of several well know methods. The catalyst thus formed is in contrast to ordinary chromium oxide dehydrogenation catalysts not poisoned by sulphur or sulphur compounds. The dehydrogenation reaction is carried out at approximately 100 pounds pressure, 800 to 1100° F. and at a flow rate of 1 to 10 liquid volumes per hour per volume of catalyst.

U.S.P. 2,297,695. Hydrocarbon Reforming. Gustav Egloff to Universal Oil Products Company.

A hydrocarbon distillate comprising naphtha and a heavier naphthenic oil is reformed in two catalytic zones, the first of which contains a dehydrogenation catalyst and the second a cracking catalyst.

U.S.P. 2,300,971. Catayltic Dehydrogenation Process. R. M. Roberts and J. Burgin to Shell Development Company.

Hydrocarbons are dehydrogenated by passing their vapors under dehydrogenation conditions at a continuously decreasing temperature caused by the endothermic heat of the dehydrogenation reaction through an essentially adiabatic converter which contains a fixed bed of plurality of dehydrogenating catalysts of varying composition, comprising an alumina having a relatively high optimum dehydrogenation temperature and a promoter having a relatively low optimum dehydrogenation temperature. The vapors are preheated to about the optimum dehydrogenating temperature of the first contacted portion of catalysts and the catalysts are so arranged that the proportion of the promoter varies inversely with the temperature along the length of the converter.

U.S.P. 2,301,727. Conversion of Hydrocarbons into Gaseous Olefins. H. Klein, F. Hanbach and W. Hofeditz to The Alien Property Custodian. C.A. 37,2013.

Hydrocarbon material such as ethane or propane is heated (suitably to about 600°C) in the presence of such a proportion of oxygen that at the prevailing pressure (which may be atmospheric pressure) there is no formation of a flame. The heated mixture is passed through the first part of a reaction zone at a high speed of flow and through the following part at a lower speed of flow, effected by providing a larger cross section of the apparatus used through which the materials flow.

U.S.P. 2,304,183. Multi-stage Dehydroaromatization. E. T. Laying, and R. F. Marschner to Standard Oil Company (Ind.) and to The M. W. Kellogg Company.

A process consisting of dehydrogenation and aromatization steps is described, in the first phase of which

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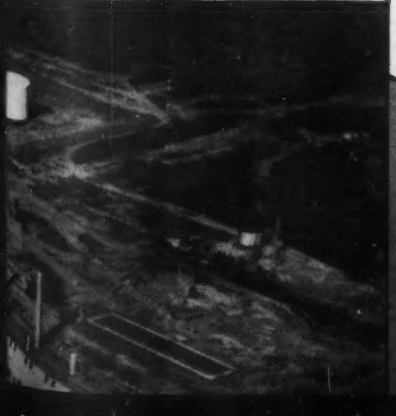

SHUT-DOWN TIME 1/10TH OF 1%

"Good Old Number 1", shown at left, has been the prize performer in this battery of CLARK "Angles" at the La Gloria Corporation recycling plant, Falfurrias, Texas. It is undoubtedly the world's champion compressor unit for continuous operation. Number 1 was shut down, in the year 1942, due to engine fault or repairs, exactly 70 minutes . . . has shown comparable performance throughout the two and a half years it has now been in operation. A year contains 525,600 minutes. 70 minutes is less than 1/100th of 1% of the total.

But this entire battery of 11 8-cylinder, 800 horsepower "Angles" were only shut down an average of 8 hours each, during 1942, due to engine fault or repairs. That was only 1/10th of 1% of the total time and is undoubtedly another world's record.

CLARK perfected 2-cycle design explains the amazing record of these engines.

Economy of lubricating oil consumption has been equally amazing. This battery started operation in May, 1941. In two and one-half years, oil has been changed in only one engine. The cause was a bad piston. There was no sign of sludge in the oil, and crankcase walls were clean.

Call on CLARK engineers for the whole story of CLARK "Angle" performance.

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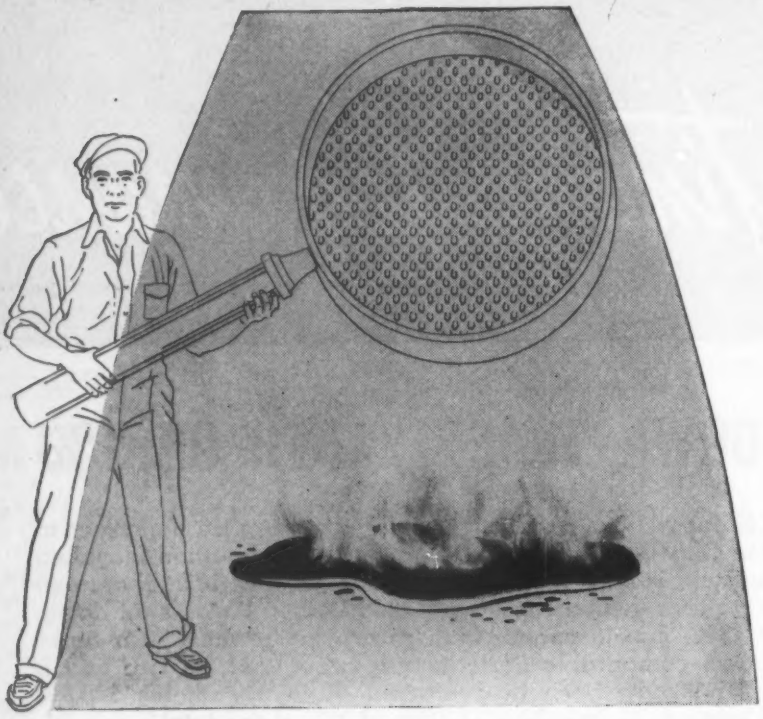
QUENCH OIL FIRES



Fire caused by flammable liquids comes quickly, unexpectedly. Then any moment a devastating conflagration might spread through the plant . . . unless ample protection has been provided.

FIRE-FOG offers such protection. This newest of "Automatic's" Systems does three things and does them automatically and amazingly well: It *blankets* . . . it *isolates* . . . it *quenches.* Millions of tiny particles of water—forming a mist-like spray—cloak and choke the flames, "island" and cool the fire, extinguish the blaze!

Many months ago "Automatic's" engineers started working on FIRE-FOG. Thousands of dollars were spent in designing, experimenting and perfecting. Today FIRE-FOG is ready for fire guard duty, and when necessary will go into action with a speed that is seemingly miraculous. Best of all, it does quickly the job it was designed to do—*quench flammable liquid fires!*

Want more information? Ask to have an "Automatic" Engineer drop in to see you. There's no obligation.

"AUTOMATIC" FIRE-FOG

★ IT BLANKETS
★ IT ISOLATES
★ IT QUENCHES

"AUTOMATIC" SPRINKLER CORPORATION OF AMERICA ★ YOUNGSTOWN, OHIO

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"AUTOMATIC" SPRINKLER CORPORATION OF AMERICA RATE OF RISE TRADE MARK REG. U.S. PAT. OFF.

naphtha is brought into contact with a dehydrogenation catalyst such as an oxide of molybdenum or chromium on alumina at a temperature of about 850 to 1000°F.

U.S.P. 2,305,538. Execution of Catalytic Conversions in the Presence of Ferrous Metals. G. E. Liedholm, R. M. Cole and I. I. Shultz to Shell Development Company.

A process is employed for the conversion of carbonaceous materials in the vapor phase at a temperature of 500°F or higher in which the reactant vapors are brought into contact in the presence of a ferrous metal, such as a chrome steel reactor, with a supported chromium oxide catalyst which is regenerated by oxidation of carbonaceous deposits which form on it and which involves inhibiting the contamination of the catalyst by iron by maintaining in the feed to the reaction zone from 0.0006 percent to 0.015 percent of sulfur in the form of vapors of sulfur or a reducible nonoxygenated sulfur compound such as thiophene.

U.S.P. 2,307,240. Manufacture of Diolefins. R. F. Ruthruff.

It has been found that when a mono olefinic charge is diluted with hydrogen and the mixture is passed, preferably at superatmospheric pressure (200 to 750 pounds) over a suitable catalyst (chromium oxide or alumina or others) at elevated temperatures, high conversions to conjugated diolefins are obtained and at the same time the production of carbon is greatly reduced. From 1 to 10 volumes of hydrogen are added to the olefins.

U.S.P. 2,307,715. Hydrocarbon Conversion. J. Turkevich to Process Management Company.

A highly active catalytic material for the dehydrogenation of hydrocarbons and particularly for the conversion of aliphatic hydrocarbons of six or more C-atoms per molecule to aromatic hydrocarbons by dehydrogenation and cyclization reactions, may be prepared by the reduction of chromic sulfate. Preferably such reduction is carried out by the passage of hydrogen over the chromic sulfate while raising the temperature thereof slowly to the reaction temperature. Chromic sulfate, e.g. is heated to 475°C. in an atmosphere of hydrogen during 12 hours and the material thus produced employed in dehydrogenating at 472° and atmospheric pressure. At a space velocity of 2, 13 percent aromatics and 9 percent olefins were obtained from heptane.

U.S.P. 2,310,523. Process for the Production of Diolefins. H. P. A. Groll, G. W. Hearne and G. E. G. von Stietz to Shell Development Company.

Objects of the invention are to provide a method for the production of diolefins by dehydrohalogenation which allows better yields to be obtained from inexpensive and available halogen compounds, which further allows the recovery of the halogen acid from the reaction product in the anhydrous form or in the form of solutions of high concentration and which is substantially free from difficulties due to coke and tar formation and does not require the use of catalysts, alkalies, steam or other reagents. The vapors of the appropriate halogen compound are passed continuously in the absence of water through a

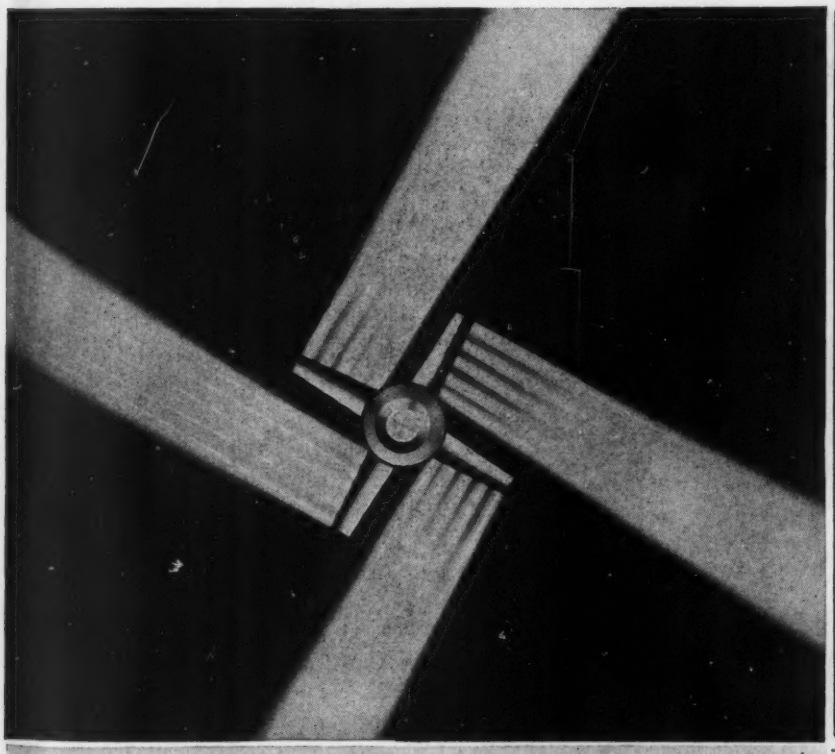
Old Installations or New!

"Pinwheel Action" is the principle of a revolutionary gas burner that uses the energy in gas under pressure to do the work of correctly proportioning gas and air and provide greater heat release.

With the Coppus-Dennis FANMIX Gas Burner, complete combustion with less than 5% excess air is guaranteed! For example, with natural gas of 1,000 B. T. U. per cubic foot, flue gas analysis of over 11% CO_2, a fraction of 1% of O_2, and no CO—is not unusual.

FANMIX gives you truly radiant heat—a high, even furnace temperature. There are no drifting "hot spots"—no secondary combustion to deteriorate furnace lining.

Let us tell you more about increasing ratings with Coppus-Dennis FANMIX. Send for free booklet 410-3.



EXCLUSIVE FANMIX PRINCIPLE

Gas under pressure, escaping from radially-spaced orifices in the driving arms, rotates the fan, causing intake of air at right angles to the path of the gas. The number of orifices, as well as the gas pressure, determines the gas flow. The reaction force determines the speed of rotation, hence the air delivery. Gas and air are thus mechanically mixed — thoroughly and in automatically correct proportions for complete combustion; without impingement.

When planning new boiler installations, you can save on:

1. ***combustion space.*** With FANMIX the furnace does not have to serve as a mixing chamber.
2. ***stack height.*** With FANMIX there is no draft loss across the burner.
3. ***installation costs.*** With FANMIX you can use smaller pipe sizes, you need no forced draft equipment., etc.

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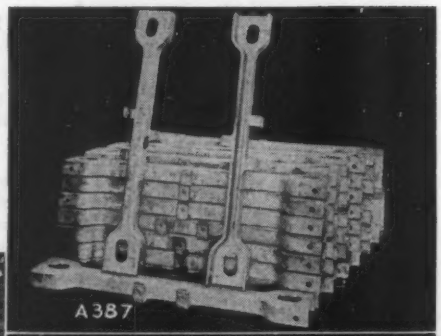
Amsco Alloy Tube Supports, *Made in Many Designs*, Are Alike in Long Life

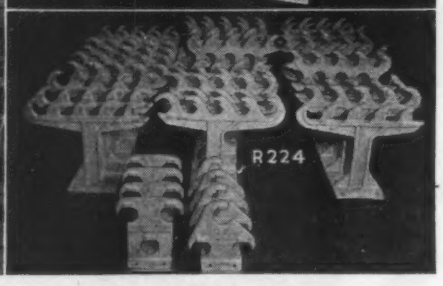
Large tonnages of Amsco Alloy tube supports have been put into service since cracking still operators discovered that this chromium-nickel alloy withstands for long periods high temperatures and corrosive conditions which quickly destroy ordinary metals with resulting excessive maintenance costs. Amsco Alloy tube supports have been made in a wide variety of patterns; far too many to portray here. Some of these were designed by refinery engineers; others by our staff. All are alike in affording long and economical service.

Amsco Alloy F-10, a grade containing 26-28% chromium and 10-13% nickel, has proved ideal for tube supports, having substantial load carrying strength at temperatures up to 2000° F., combined with high resistance to corrosion from sulphur. It also resists the stresses of repeated heating and cooling and shows satisfactory residual ductility when cold.

Other refinery applications of Amsco Alloy include beams and channels, floor pedestals, side wall brackets and tube sheets.

Ask for Bulletin No. 108 on Amsco Alloy.





R-554—A 40-ton shipment of chromium-nickel alloy tube supports made by Amsco.

A-387—Amsco design of tube supports.

R-224—A ton lot of Amsco Alloy Grade F-10 tube supports.

Amsco-Nagle Centrifugal Pumps are described in Bulletin 940

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OFFICES IN PRINCIPAL CITIES

non-catalytic reaction chamber, maintained at a suitable temperature and the diolefin and halogen acid are recovered from the effluent vapors. Temperatures of 560 to 770°C. are used.

U.S.P. 2,311,979. Process for Dehydrogenating Hydrocarbons. B. B. Corson and M. W. Cox to Universal Oil Products Company.

Dehydrogenating catalysts are prepared by intimately associating an oxide of an alkaline earth metal with mixtures of oxides of aluminum and chromium. A catalytic material with high dehydrogenating activity and a low carbon forming tendency is obtained. The amount of alkaline earth oxide required varies with the ratio to chromia to alumina and other factors but is in the range of 1 to 15 percent by weight of the composite. Dehydrogenation reactions with this catalyst are carried out at 450 to 750°C.

U.S.P. 2,313,162. Treatment of Hydrocarbons. J. C. Morrell and A. V. Grosse to Universal Oil Products Company.

A process for the dehydrogenation of aliphatic hydrocarbons having less than six C-atoms in straight-chain arrangement to produce unsaturated derivatives thereof is described which comprises subjecting the aliphatic hydrocarbons at a temperature of the order of 450 to 700°C., absolute pressure of the order of 0.25 to 7 atmospheres and a time from approximately 0.1 to 10 seconds to contact with a solid granular catalyst comprising essentially aluminum oxide which has a relatively low catalytic activity supporting an oxide which has a relatively high catalytic activity, selected from the group consisting of the oxides of vanadium, cobalt and tantalum.

U.S.P. 2,315,107. Catalytic Dehydrogenation. J. Chickinoff, R. M. Roberts and J. Burgin to Shell Development Company.

Hydrocarbon vapors containing from 2 to 5 C-atoms are dehydrogenated with an iron oxide-alumina dehydrogenation catalyst in an essentially adiabatic reaction zone. A temperature gradient not greater than about 100°C. is maintained in the reaction zone by passing a molecular excess of preheated vapors of hydrogen sulfide there through in admixture with the hydrocarbon vapors. The hydrogen sulfide vapors are preheated to a temperature in excess of the desired reaction temperature.

U.S.P. 2,315,506. Catalytic Treatment of Petroleum Hydrocarbons. P. S. Dauner and R. C. Mithoff to Standard Oil Company of California.

A two-stage catalytic process is described. Hydrocarbons of low octane number are dehydrogenated in the presence of catalysts like bauxite, precipitated alumina, zinc oxide, stannic oxide, zirconium oxide, thorium oxide at temperatures from 850 to 950°F. and in the absence of added hydrogen. No substantial cracking occurs. Introduction of steam along the hydrocarbons increases the active catalyst life without interfering with the reaction. In the second phase products from the first are stabilized by passing them in vapor phase at 570 to 660°F. over a catalyst like tungsten oxide, alumina, bauxite and Florida clay. An aromatization occurs.

U.S.P. 2,316,271. Treatment of Hydrocarbons. W. J. Mattox to Universal Oil Products Company.

Hydrocarbons are vaporized, mixed with regulated amounts of hydrogen (in

1/10 TO 100 HORSEPOWER
Five types of gearhead motors have reduction ratios ranging up to 432 to 1.
You can secure Master Gearhead Motors for mounting in any position because anti-friction bearings and all-metal lubricant seals are used throughout.
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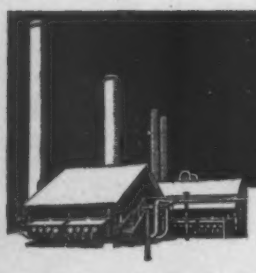
Save material and save space with simple, compact, integrally built Master gearhead motors.
Available in a wide range of types including explosion proof, splash proof, fan cooled, multi-speed uni-brake motors and Speedrangers.

Recognition of the power of fire is typified by ancient fire worship practices. As fire became subjugated to the will of man, it became the tool of civilization, rather than the symbol of awesome religion. The power of fire for usefulness is typified by its control for the purposes of modern petroleum processing. Pioneering in heat research and in the engineering application of heat to the many necessities of the industry, Alcorn has designed and erected furnaces which have resulted in lower operating costs and higher production efficiency in many world important refineries. Alcorn's 20 years experience, continued research and knowledge of the new techniques of the industry are at your service.



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the molecular ratio of .5 to 40 volumes of hydrogen per volume of hydrocarbons) and passed over beds of selective granular catalysts such as chromium oxide, aluminum oxide or molybdenum oxide at temperatures from 450 to 650°C., and pressure, space velocities and particularly mass velocities giving the optimum conversion with minimum carbon deposition.

U.S.P. 2,319,452. Treatment of Cyclic Hydrocarbons. A. V. Grosse and W. J. Mattox to Universal Oil Products Company.

Naphthenic hydrocarbons are dehydrogenated by subjecting their vapors at a temperature ranging approximately from 400 to 650°C. under a pressure from atmospheric to 100 pounds, for a time of 0.01 to 60 seconds to contact with gamma alumina, supporting less than 20 percent by weight of a compound selected from the group consisting of vanadium, columbium and tantalum. Other catalyst supports are magnesium oxide, aluminum oxide, bauxite, bentonite clays, montmorillonite clays, kieselguhr, crushed silica, crushed firebrick and glauconite.

U.S.P. 2,315,499. Production of Paraffin-Olefin Mixtures. A. Crantzler and H. Krekeler to Standard Catalytic Company.

Mixtures of paraffins and olefins are obtained by mixing paraffn hydrocarbons of at least two carbon atoms with at least an equimolecular amount of hydrogen chloride and exposing the mixture to temperatures above 500°C., but keeping it below temperatures at which splitting of the carbon chain may occur. The throughput rate must be high enough to dehydrogenate only part of the charge.

U.S.P. 2,320,274. Conversion of Normally Gaseous Hydrocarbons. E. Gorin to Socony-Vacuum Oil Company.

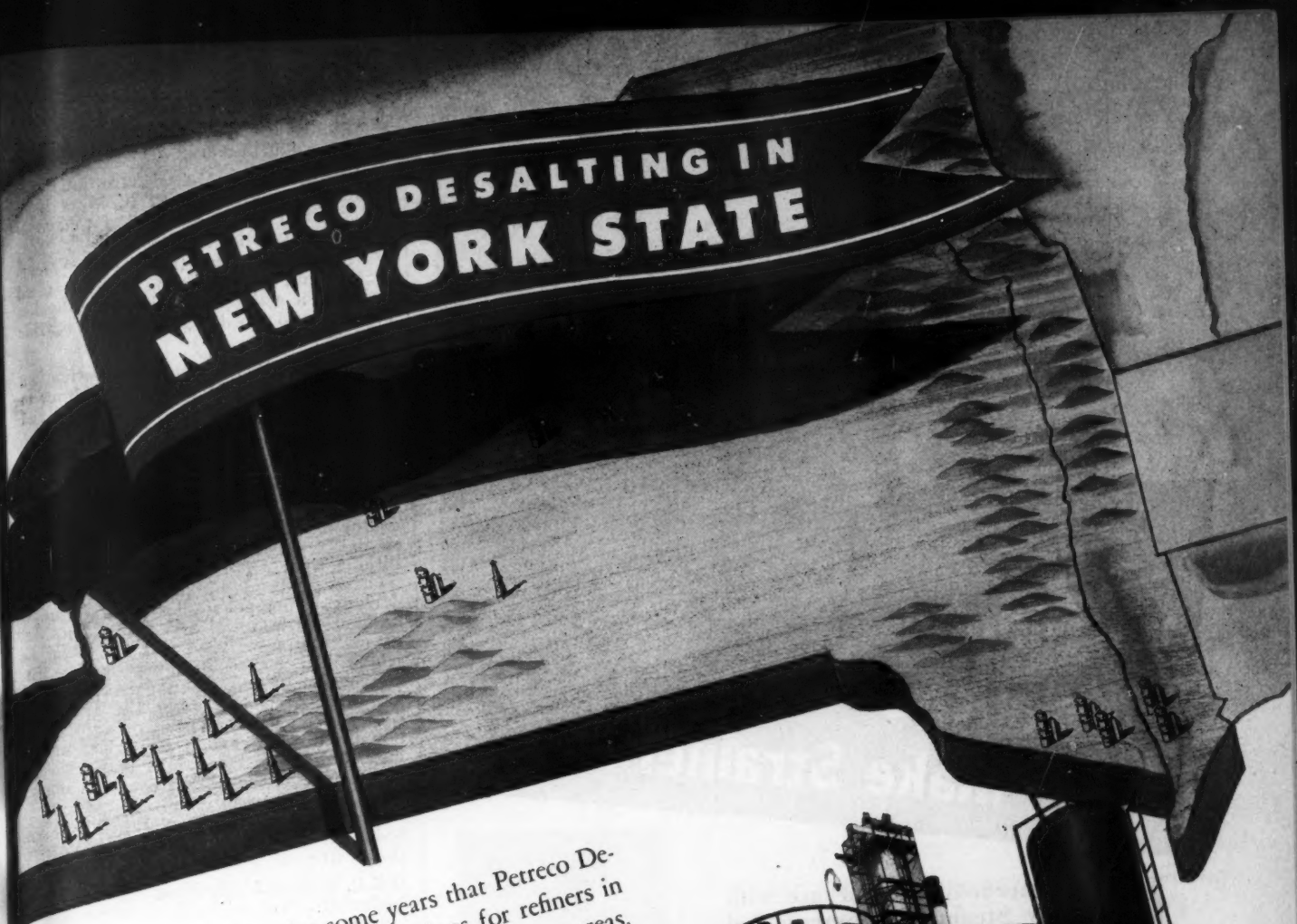
Paraffins are halogenated in a first stage to form an alkyl halide charge stock containing at least 20 percent by volume of alkyl halides. In a second stage the alkyl halide charge stock is pyrolized at a temperature above about 500°C. to give benzene, ethylene and acetylene.

U.S.P. 2,321,551. Catalytic Dehydrogenation and Hydrogenation. D. J. Loder to E. I. DuPont de Nemours & Company.

Phenol is obtained from benzene by subjecting benzene and at least one substance of the group consisting of cyclohexanone and cyclohexanol to a catalytic hydrogen exchange reaction at a temperature within the range of 70 to 350°C. and separating phenol and cyclohexane from the resultant product.

U.S.P. 2,322,857. Dehydrogenation Process. G. E. Liedholm, R. M. Cole and I. I. Shultz to Shell Development Company.

As an improvement in a dehydrogenation process wherein a hydrocarbon having from 2 to 5 carbon atoms is contacted in the presence of a ferrous metal at an elevated temperature of at least 750°F. with a sulfur active dehydrogenation catalyst susceptible to contamination by iron, the step is claimed which consists of predrying the hydrocarbons to be dehydrogenated to a water content not greater than 0.005 percent by weight and maintaining in



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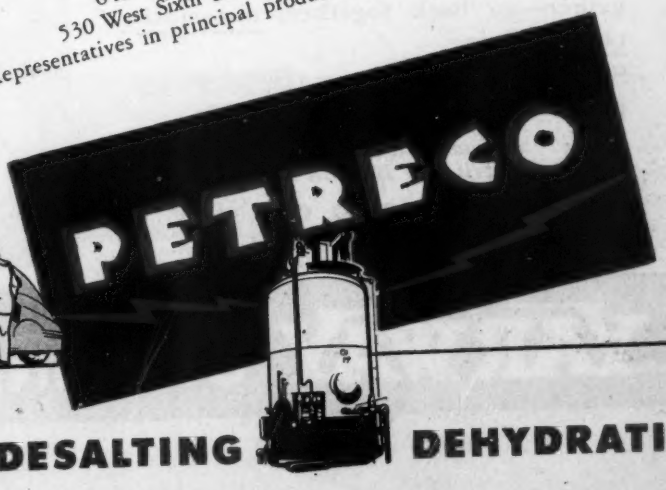
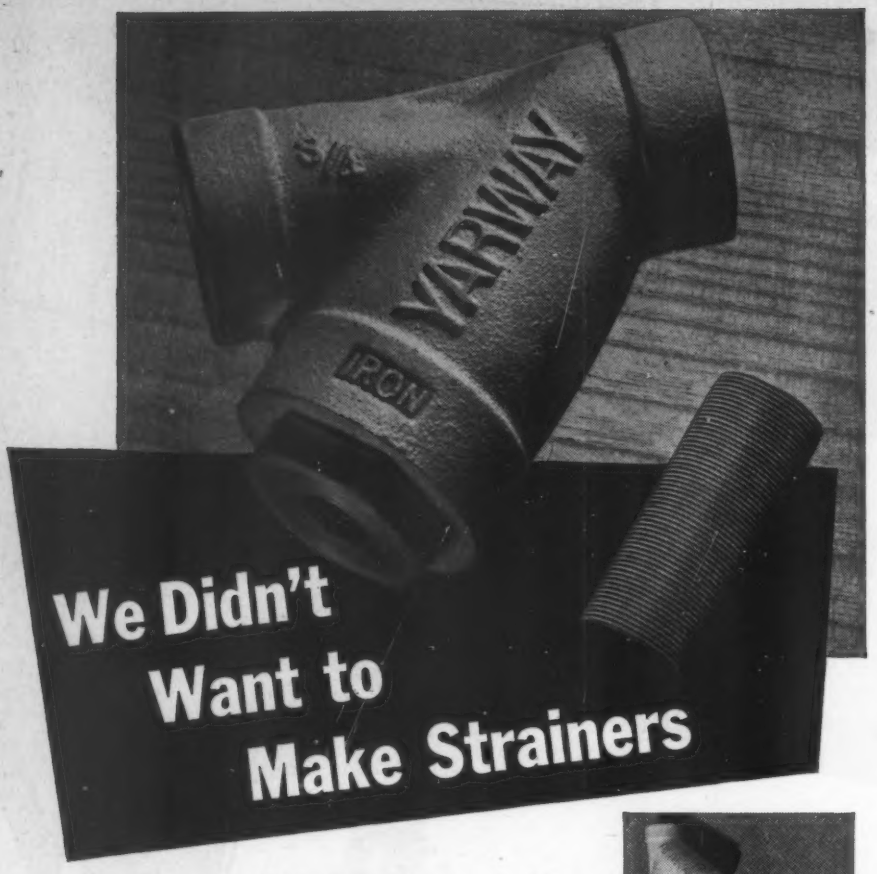


DESALTING DEHYDRATING



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U.S.P. 2,322,863. Dehydroaromatization and Hydroforming. R. F. Marschner, L. Heard and A. G. Oblad to Standard Oil Company (Indiana).

Processes of catalytic dehydroaromatization and hydroforming are integrated to form a self contained system which requires no hydrogen from outside sources.

U.S.P. 2,324,165. Dehydroaromatization. E. T. Layng and R. F. Marschner to Standard Oil Company (Indiana) and The M. W. Kellogg Company.

Dehydrogenation catalysts such as molybdenum oxide on alumina, chromium oxide on alumina, etc., cause ring closure and/or convert naphthenes to aromatics. Some naphtha fractions thus treated require different conversion conditions than others. The hydrocarbons consisting—predominantly—of 6 and 7 carbon atoms per molecule fraction is reacted with relatively fresh catalyst of maximum activity and the catalyst which has served its purpose for the conversion of this fraction is thereafter employed for converting the fractions consisting predominantly of hydrocarbons of 8 to 12 carbon atoms per molecule. Operating conditions in both catalyst systems may be the same, namely 30 to 450 (preferably 250) pounds pressure at 875 to 1075 (preferably 950)°F. bed temperature, and space velocities of about 0.04 to 10.

U.S.P. 2,325,015. Hydrocarbon Conversion. J. Turkevich to Process Management Company.

Hydrocarbons are dehydrogenated at elevated temperatures such as 475°C. for heptane at a space velocity of 1.33 volumes (liquid basis) with a catalyst prepared by reducing an ammonium salt of a heteropoly acid of molybdenum containing as the nuclear element a member selected from the group of aluminum and phosphorous. The reducing conditions must be sufficiently severe to effect substantial removal of oxygen atoms from the heteropoly compound, but sufficiently mild to maintain in the residue the characteristic structure of the heteropoly compound. Using the catalyst prepared from aluminomolybdic acid, 170 volumes of gas per liquid volume of heptane charged were obtained. The gas contained 85 percent hydrogen, the liquid 17 percent aromatics and 4 percent olefins.

U.S.P. 2,325,911. Catalytic Dehydrogenation. H. C. Huffman to Union Oil Company of California.

The presence of a dehydrogenation catalyst of a small amount of a beryllium compound such as beryllia, not only increases the activity of the catalysts to a large extent but maintains the catalyst life at a high level for a considerably longer time than in the absence of the baryllium compound. This is particularly true in the case of chromium or molybdenum oxide distended on alumina. A composition of 1 to 10 percent of chromium oxide, 75 to 98 percent alumina and 1 to 15 percent beryllia is an excellent catalyst. A dehydrogenation temperature of about 1050°F. is used.

U.S.P. 2,325,287. Process for Hydrocarbon Conversion. C. L. Thomas to Universal Oil Products Company.

A catalyst for the dehydrogenation of hydrocarbons under dehydrogenating conditions is described which consists

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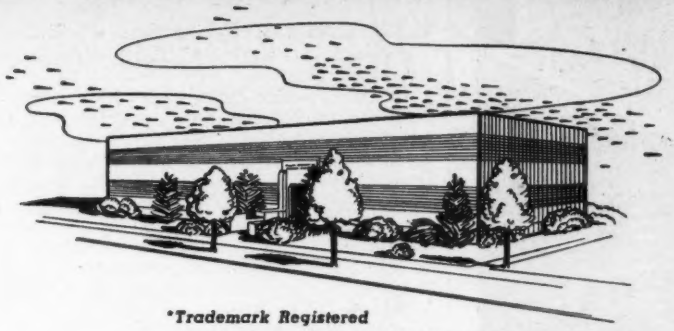

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of active alumina containing chromia, the catalytic activity of the composition being promoted by the addition thereto of minor amounts of an oxide of a metal selected from the group consisting of cerium, thorium and manganese.

U.S.P 2,326,258. Production of Butadiene. O. Schmidt to Alien Property Custodian.

Butadiene can be prepared in excellent purity by the dehydrogenation of butylene at above 500°C. N-butylene in admixture with carbon dioxide and free oxygen is passed through vessels heated to above 500°C. The reaction is conducted in the presence of an oxydation catalyst. The speed of reaction is selected so that only part of the butylene is converted, the amount of oxygen admixed being from 1 to 2 mol proportion for each mol proportion of hydrogen split off and the amount of carbon dioxide being at least equimolecular to the amount of oxygen.

F. G. Fellows Opens Office as Consultant

Fred G. Fellows, former superintendent of the Ponca City refining plant of Continental Oil Company, has opened offices at 201½ East Grand Avenue in that city and will engage in the practice of consulting civil and industrial engineer. He was superintendent at Ponca City from 1929 until 1942.

Prior to 1925 he followed the engineering profession in Colorado and Wyoming, chiefly in the design and construction of municipal, irrigation and water-supply projects. He was the engineer in charge of final designs and surveys of the model town, Parco, Wyoming, built by the former Producers and Refiners Corporation. It is now Sinclair, Wyoming.

He came to the Marland Oil Company as an engineer in 1925 and became superintendent of the plant in 1929. He is an associate member of the American Society of Civil Engineers, a member of the American Chemical Society and the American Petroleum Institute, and is a registered professional engineer in Oklahoma and Colorado.

F. G. FELLOWS

Japanese Report Fuel Made from Palm Oil

Because the Japanese have by radio given the world notice of methods of making motor fuel from palm oil, the Netherlands Information Bureau, New York, has drawn the conclusion that the conquerors have not been successful in rehabilitating the refining plants that fell into their possession in the conquest of the Netherlands East Indies.

Details of getting motor fuel from palm oil give little insight into the method. As reported by the information bureau, it is based on some experiments done by the Dutch but:

"They (the Japanese) claim that their processing method is simpler and more economical than previous methods. Their contention is based on the fact that it does not require 'absolute' alcohol (99 percent dehydrated) and sulphuric acid and consequently the need for acid-resisting equipment. Their process utilizes only refined palm oil, water, caustic soda and commercially pure alcohol (95 percent dehydrated.) Futhermore their process takes less time, the announcer said, while the resultant fuel is practically free from the danger of putrefaction."

Two years ago the Japanese came into possession of the Far Eastern archipelago and its annual production of 58,000,000 barrels of oil. Since the information was given as to palm oil, the conclusion is:

"After two years of occupation the Japanese will have not succeeded in repairing all the Netherlands East Indies oil refineries which were so thoroughly destroyed by the Dutch when they retreated from the Islands in March 1942."

War Damage Insurance Free for Third Year

Oil companies and operators who have been carrying government war risk insurance for the past two years will automatically be carried for another 12 months from March 31 without payment of additional premiums, Secretary of Commerce Jesse Jones has announced.

No action on the part of policyholders will be required for the extension, but any additional insurance written after April 1 will have to be paid for at the existing rates.

The War Damage Corporation was created two years ago to provide insurance of property against bombing or other war hazards. Premiums collected to the end of 1943 totaled $218,000,000 after payment of all expenses.

Power Conference Program Is Announced

The program for the 17th National Oil and Gas Power Conference to be held at the Mayo Hotel, Tulsa, May 8-10, includes a variety of papers dealing with present and postwar internal-combustion engines problems will be read including control for aviation, marine and railroad engines, governing of engine generators in parallel, controls for pipe-line engines, operation of pipeline stations, aircraft engine maintenance and design. Looking to the future papers will discuss gas-turbine engine prospects, development in turbocharging and design and progress in diesel-gas engines.

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ABSTRACTS OF PAPERS

Presented at

Division of Petroleum Chemistry of the American Chemical Society

Cleveland, Ohio, April 3 to 7, 1944

Factors Relating to Postwar Motor Gasolines. Alberta H. Adams and B. H. Weil, Information Section, Chemistry Division, Gulf Research & Development Company, Pittsburgh, Pa.

Consensus among automotive and petroleum experts indicates that some 15,000,000 of the nation's prewar 30,000,000 cars will remain in operating condition at the war's end, maintaining, with the help of some military consumption and increased commercial and farm use, a volumetric market for gasoline of at least 75 percent of the prewar level. A rapid recovery to or above normal prewar use is expected to follow as new tires and cars come into production. The immediate postwar cars will probably be the 1942 models, with changes in automobile design expected to come slowly. One hundred-octane automotive fuels are not to be required for some years, if ever.

Combustible Gases as Substitute Motor Fuels. Gustav Egloff and Mary Alexander, Universal Oil Products Company, Chicago, Ill.

Combustible gases have replaced over 3,000,000 barrels of gasoline in the operation of about 140,000 motor vehicles in Europe, since these gases come from domestic sources. Even in the United States, propane and butanes are used in about 25,000 vehicles. Methane, ethane, propane, and the butanes are obtained from oil and natural-gas wells, refineries, coal mining and processing, sewage, and city gases. Acetylene, ammonia, and hydrogen are used in countries particularly where there is abundant water power to furnish electric energy. Utilization of all these fuels has been limited in Europe, since high-pressure equipment requires materials of which there is a shortage. Although at present the equipment is much heavier, the fire hazard greater and commercial distribution poorer than with gasoline, gases may play an important role in the future of motor transport.

Method for Determining Individual Hydrocarbons in Mixtures of Hydrocarbons by Measurement of Freezing Points. Anton J. Streiff and Frederick D. Rossini, National Bureau of Standards.

A method is described for determining individual hydrocarbons in mixtures of hydrocarbons by measurement of freezing points. Experimental data are given for the determination of the four C_8 aromatic hydrocarbons. The uncertainty of the determination of each hydrocarbon is near ± 1 percent of the total sample.

Theoretical Analysis of Certain Time-Temperature Freezing and Melting Curves as Applied to Hydrocarbons. William J. Taylor and Frederick D. Rossini, American Petroleum Institute Research Project 44, National Bureau of Standards, Washington, D. C.

A method is described for determining analytically or graphically, from appropriate time-temperature freezing and melting curves obtained on hydrocarbons, the freezing point of a given hydrocarbon substance, and, within certain wide limits, the freezing point of that substance for zero impurity (liquid-soluble, solid-insoluble).

Phase Equilibria in the Ethane-Ethylene-Acetylene System. J. Lloyd McCurdy, Standard Oil Company of California, and D. L. Katz, University of Michigan.

An experimental study of the phase equilibrium relationships of the ethane-ethylene-acetylene system has been carried out at two temperatures, 40° and 60° F., and at a series of pressures in 50-pound intervals covering the entire two-phase region at each temperature.

The constant-boiling mixtures of the ethane-acetylene and ethylene-acetylene system persist through the triangular three component diagrams. At constant temperature and pressure these diagrams have two two-phase areas. Acetylene is the most volatile constituent in one area and the least volatile in the other area.

Correlation of Vapor Liquid Equilibria Data. C. O. Miller, Case School of Applied Science, and R. C. Barley, E. B. Badger & Sons Company.

It has been found empirically that for the n-paraffin hydrocarbons from propane through n-octane the vapor fugacity (fy) is a single function of total pressure. It was known previously that for a given substance liquid fugacity (f_x) is a single function of temperature. By employing these two relations, values derived from the experimental vapor-liquid equilibria data of Katz and Hachmuth have been correlated. The correlation is presented in the form of an alignment chart with scales for temperature, pressure, and equilibrium constants ($K = y/x$), and points representing various light hydrocarbons.

Vapor Pressures in Hydrocarbon-Furfural-Water Systems. Clark Holloway, Jr., and S. H. Thurber, Gulf Research & Development Company, Pittsburgh.

Systems of four hydrocarbons with a furfural-water solution have been studied with respect to cloud point, vapor pressure, and density. Isobutane was found to be the least soluble in the 4 weight percent water—96 weight percent furfural mixture, followed by *n*-butane, butene-1, and butadiene-1,3. Isothermal vapor pressure and density data were also taken at four temperatures above the cloud point curves: 250°, 200°, 150° and 100° F. These vapor pressure data permitted the calculation of activity coefficients which are presented as plots of y versus x for each system at the four temperatures listed. Experimental vapor pressures for butene-1 and butadiene-1,3 are given up to 250° F.

2-Methylbicyclo-(2,2,1)-Hept-5-Ene, 2-Methylbicyclo-(2,2,1)-Heptane, and 2-Methylbicyclo-(2,2,2)-Octane. George Calingaert, Harold Soroos, and Hymin Shapiro, Ethyl Corporation.

2-Methylbicyclo-(2,2,1)-hept-5-ene, 2-methylbicyclo-(2,2,1)-heptane, and 2-methylbicyclo-(2,2,2)-octane, hydrocarbons having highly compact and symmetrical structures, were synthesized for the purpose of evaluating their antiknock properties. Diels-Alder condensations of propylene with cyclopentadiene and 1,3-cyclohexadiene gave, respectively, 2-methylbicyclo-(2,2,1)-hept-5-ene and 2-methylbicyclo-(2,2,2)-oct-5-ene, and hydrogenation of the two bicycloolefins over nickel catalyst gave the corresponding saturated hydrocarbons, 2-methylbicyclo-(2,2,1)-heptane and 2-methylbicyclo-(2,2,2)-octane.

The octane numbers of the three bicyclic hydrocarbons were determined and compared with the values reported for bicyclo-(2,2,1)-hept-2-ene, bicyclo-(2,2,1)-heptane, and several isomeric cycloparaffins. 2-Methylbicyclo-(2,2,1)-hept-5-ene gave an octane number of 97 and showed a low susceptibility toward tetraethyllead. 2-Methylbicyclo-(2,2,1)-heptane and 2-methyl-bicyclo-(2,2,2)-octane showed octane numbers of 70 and 51, respectively, values considerably lower than predicted on the basis of their compact and symmetrical structures; both showed high susceptibility toward tetraethyllead.

Selectivity of Solvents for Various Types of Hydrocarbons as Measured by Critical Solution Temperature. Alfred W. Francis, Socony-Vacuum Oil Company, Paulsboro, New Jersey.

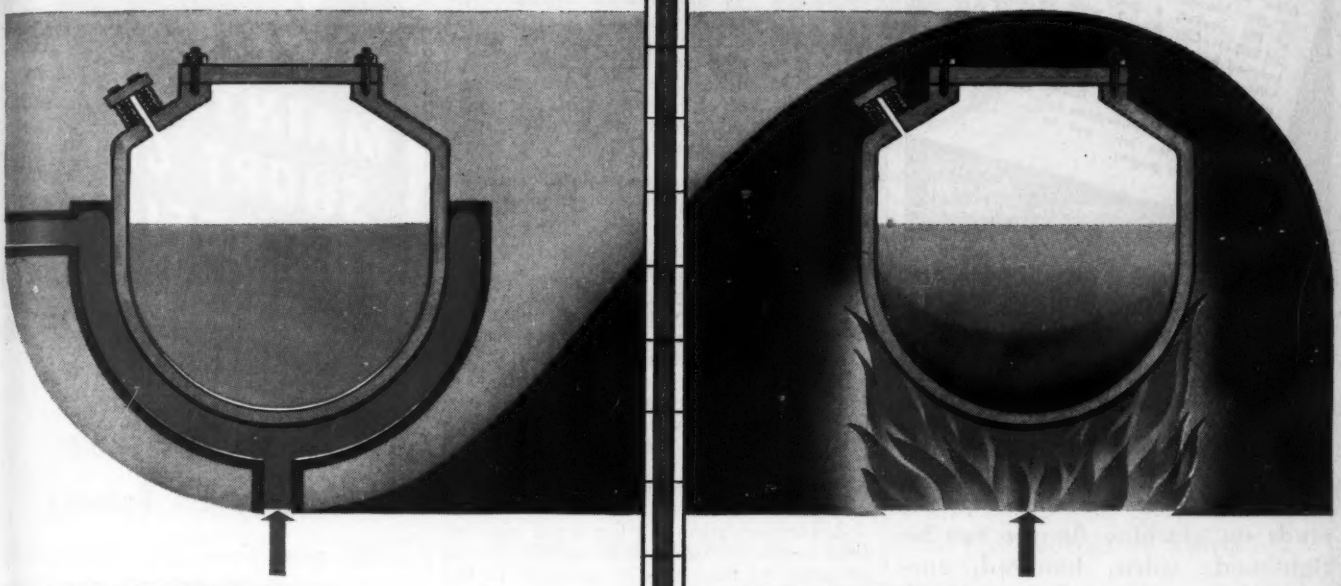
Critical solution temperatures have been determined for over 100 solvents of various types with 10 representative hydrocarbons, 2 straight-chain paraffins, a branched-chain paraffin, two olefins, two naphthenes, paraffin wax, and two commercial oils. Aromatic hydrocarbons are too miscible with these solvents to observe the critical solution temperature.

The differences in critical solution temperatures for the same solvent with different hydrocarbons is taken as a measure of the relative affinity or selectivity of the solvent for the two types of hydrocarbon. Selectivities for olefins, naphthenes, branched chains, type of oil, and molecular weight are calculated and plotted against each other to show their extent of interrelation.

Effects of substituent groups in the solvents are estimated. The methyl and phenyl groups usually lower the critical solution temperature about 40° C. The nitro and carboxyl groups raise it over 100° C.

A Simple Test for Measuring the Corrosivity of Used Engine Oils. R. G. Larsen, F. A. Armfield, and L. D.

end the danger of LOCAL OVERHEATING



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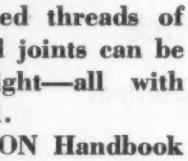

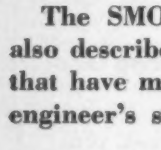

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Hydrocarbon Reactions in the Presence of Cracking Catalysts. II. Hydrogen Transfer. Charles L. Thomas, Unisal Oil Products Company.

Normal octenes were converted by a synthetic silica-alumina-zirconia catalyst at 375° C. mainly into octanes, aromatic hydrocarbons, and a hydrogen-poor catalyst deposit. The reactions that occured were:

1. Hydrogen transfer reactions resulted in the conversion of olefins into paraffins. At the same time, products poorer in hydrogen, such as aromatic hydrocarbons and the catalyst deposit, were formed.
2. Isomerization; earlier work showed that *n*-octenes isomerized rapidly in the presence of this type of catalyst. In the present test the iso-C_8 fraction constituted 93 percent of the C_8 cut.
3. Scission of carbon-carbon bonds to form products containing fewer than eight carbon atoms; the tendency of this type of catalyst to form cracked products containing three or more carbon atoms was again demonstrated.
4. Polymerization or condensation to form products containing more than eight carbon atoms; these products included higher boiling liquids as well as the solid and semi-solid material deposited on the catalyst.
5. Cyclization; aromatics within the boiling range of the xylenes, as well as still-higher-boiling aromatics, were formed. The formation of the aromatics may have been preceded by the formation of the corresponding cycloparaffin. The evidence for the presence of the cycloparaffins is less convincing than that for the aromatics.

Some of the commercial processes for producing aviation fuel, contact gasolines containing olefins with cracking catalysts to reduce the olefin content, increase the aromatic content, and improve the susceptibility to tetraethyllead. The reactions described in the present article aid in understanding the chemistry of these processes.

Hydrocarbon Reactions in the Presence of Cracking Catalysts. III. Cyclohexene, Decalin, and Tetralin. Herman S. Bloch and Charles L. Thomas, Universal Oil Products Company.

A study was made of the reactions, at atmospheric pressure, of cyclohexene in the presence of a synthetic silica-aluminathoria catalyst at 250°-400°; of tetralin with a synthetic silica-alumina-zirconia catalyst at 400°-500°; and of the decalin with the latter catalyst in both the fresh and partially spent state at 400°-500°.

The principal reaction products isolated from cyclohexene were methylcyclopentenes-1 and -2, methylcyclopentane, a mixture of unidentified liquids boiling higher than cyclohexene, and 2,6-

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dimethylnaphthalene. The principal reactions of cyclohexene under the conditions studied were (1) isomerization, (2) polymerization, and (3) hydrogen transfer. The hydrogen transfer was primarily from the polymer resulting in the formation of dimethylnaphthalenes and the hydrogenation of the methylcyclopentenes to methylcyclopentane.

Naphthalene was the product formed most abundantly from tetralin. Scission of the hydroaromatic ring gave benzene, toluene, xylenes, possibly ethylbenzene, and higher-boiling alkylated benzenes. No alkenylbenzenes were isolated. They might have been formed and then converted into the corresponding alkyl derivatives by hydrogen made available by the conversion of tetralin to naphthalene. Some of the tetralin was converted to bicycloparaffins, presumably decalin or its isomers. The products can be explained by reactions of (1) scission of the hydroaromatic ring and (2) hydrogen transfer. Apparently isomerization also occurred, for the xylene fraction contained xylenes other than *o*-xylene.

The chief products formed from decalin were decalin isomers, C_3 and C_4 olefinic and paraffinic gases in which iso-butane predominated, methylcyclopentane, and probably cyclohexane and the corresponding olefins. In addition, tetralin or its isomers was found, and the aromatic reaction products of tetralin conversion indicated above. The products can be explained by the following reactions of decalin and the intermediate tetralin: (1) isomerization, (2) ring scission, and (3) hydrogen transfer.

Hydrocarbon Reactions in the Presence of Cracking Catalysts. IV. Removal of Side Chains from Aromatics. Charles L. Thomas, James Hoekstra, and John T. Pinkston, Universal Oil Products Company.

The cracking of ethylbenzene, cumene, *n*-butylbenzene, and technical amylbenzene in the presence of synthetic catalysts of the silica-alumina type was studied in the temperature range of 400° to 500° C. and atmospheric pressure. Benzene and the corresponding alkene were formed with ease and great selectivity when the side chain containd three or more carbon atoms. The yield of benzene was at least 90 percent of theory in each case. The order of decreasing susceptibility to cracking was cumene, the technical amylbenzene, *n*-butylbenzene, and, in a lower order of magnitude, ethylbenzene. No toluene, styrene, etc., was found in any product in this study.

The alkenes formed apparently underwent subsequent reactions to some extent, for some hexenes were formed in the cumene tests, presumably by polymerization of the initially formed propylene. The olefinic products from butylbenzene underwent the hydrogen transfer reaction; some butanes were formed.

Reaction of Methylcyclopentane With Olefins in the Presence of Sulfuric Acid and Hydrogen Fluoride Catalysts. Herman Pines and V. N. Ipatieff, Universal Oil Products Company.

The study of the reaction of cycloparaffins with olefins was undertaken in order to gain a better understanding of the alkylation reaction, since the ring hydrocarbons can readily be detected and identified.

For this study, methylcyclopentane was chosen as the hydrocarbon to be

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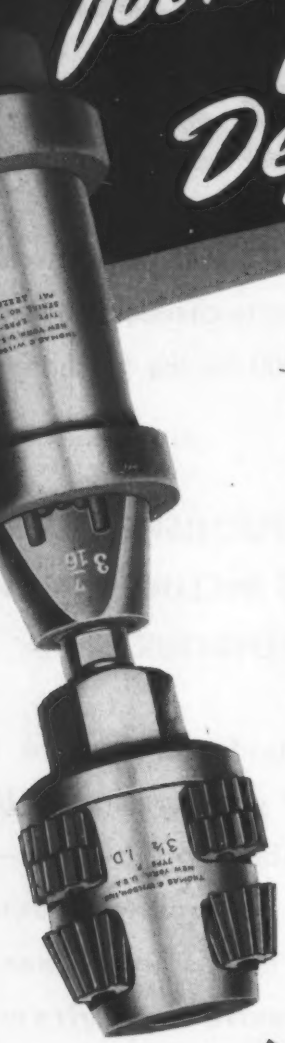

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alkylated in preference to the more accessible cyclohexane, for the reason that it undergoes alkylation more readily and at the same time it permits observation of whether or not isomerization of the cyclopentane to cyclohexane ring occurs. It is known that at room temperature the equilibrium is mostly toward cyclohexane side. Alkylation with the following olefins was investigated: propene, *n*-butenes, isobutylene, pentene-2, 3-methylbutene-1, and 2,4,4,-trimethylpentene-1 and -2. The alkylation was carried out in the presence of sulfuric acid and hydrogen fluoride, since these two catalysts, under the experimental conditions used, cause practically no isomerization of saturated hydrocarbons.

It has been found that the reaction of methylcyclopentane with olefins is accompanied by a complex reaction involving (a) addition of olefins to methylcyclopentane accompanied by ring expansion and migration of alkyl groups within the ring, (b) hydrogen disproportionation, the naphthenes being usually the hydrogen donors; whereas the olefins are the hydrogen acceptors, (c) isomerization of normal chain olefins to isoolefins followed by hydrogenation, (d) interreaction of partially dehydrogenated naphthenes to form polycyclic olefinic or polycyclic saturated hydrocarbons, (e) depolymerization and/or depolyalkylation. The ease with which the above-mentioned reactions occur depends to a great extent upon the olefins used. The unsaturated hydrocarbons formed during the reaction are usually found in the catalyst layer, from which they can be recovered by diluting with water.

The Alkylation of Isoparaffins by Olefins in the Presence of Hydrogen Fluoride. Carl B. Linn, Universal Oil Products Company, and Aristid V. Grosse, Catalytic Development Company. (Contribution of Universal Oil Products Company.)

Hydrogen fluoride catalyzes the interaction of olefins and isoparaffins to form saturated products consisting of highly branched paraffinic hydrocarbons. The alkylation was carried out, both in continuous and batch operations, in the laboratory. The effects of temperature, contact time, isoparaffins to olefin ratio, and catalyst concentration were studied.

Runs involving the paraffins isobutane and isopentane, and the olefins, propene, isobutylene, butene-1 and butene-2, are reported; also the production of alkylate from a mixture of butanes and butylenes.

Normally the fluorine content of the alkylate is low and can be reduced by further treatment.

California Association Will Meet In October

California Natural Gasoline Association will hold its regular annual meeting in Los Angeles on Friday, October 13, 1944. The date this year has been set earlier than usual to avoid conflicts with other meetings usually held the latter part of October or early November. Information concerning the program and other details may be obtained from the secretary, George L. Tyler, at 510 West 6th Street, Los Angeles.

The regular outdoor meeting of the Association is scheduled for Saturday, June 3, at Rio Hondo Golf Club, Downey, California.

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Fundamental Physical And Chemical Data

The Heat Capacity, Heat of Transition, Vaporization, Vapor Pressure and Entropy of 1, 1, 1-Trichloroethane. T. R. RUBIN, B. H. LEVEDAHL AND D. M. YOST. *Jour. Amer. Chem. Soc.* **66** (1944) pp. 279-82.

The heat capacity of 1,1,1-trichloroethane was measured with a temperature range 14° K. at room temperature. There is a transition point in the solid at 224.20° K. The heat of transition is 1786 ± 2 cal./mole. An approximate value for the melting point is 240—2 ± 0.5° K., and a rough value for the heat of fusion is 450 ± 300 cal./mole. The heat of vaporization is 7962 ± 12 cal./mole at 286.53° K. The entropy of the ideal gas at 286.53° K. and 1 atmosphere is 76.22 ± 0.16 cal./deg./mole, and 76.97 ± 0.16 cal./deg./mole at 298.16° K. and 1 atmosphere. The entropy of the liquid at 298.16° K. is 54.37 ± 0.11 cal./deg./mole. A comparison of the statistical and calorimetric values of the entropy indicates a barrier of 2700 ± 350 cal./mole.

The Density and Transition Points of the n-Paraffin Hydrocarbons. W. F. SEYER, R. F. PATTERSON AND J. L. KEAYS. *Jour. Amer. Chem. Soc.* **66** (1944) pp. 179-82.

In a previous paper one of the authors published information on the density and transition points of dicetyl ($C_{32}H_{66}$). Since that time, all the even-numbered hydrocarbons, beginning with $C_{16}H_{34}$ and ending with $C_{34}H_{70}$, have been investigated, and also the hydrocarbon $C_{29}H_{60}$ of the odd-numbered series. All of these hydrocarbons excepting $C_{16}H_{34}$ and $C_{20}H_{42}$ were synthesized in the laboratory. When alcohol served as the starting point in the synthesis the Kraft procedure was followed, and where acids were used, the electrolytic method was followed. The melting points, both calculated and observed, the setting points, and the transition points are tabulated for all of the hydrocarbons studied. Densities at the metling point or transition point are given in another table. Methods of calculating the melting points are briefly discussed. The experimental procedure used in the work is described in some detail. Density measurements indicate that the structure in the liquid and solid state is the same for all members of the series. The odd-numbered hydrocarbon C_{29} has a solid phase much less dense than the neighboring even-numbered members.

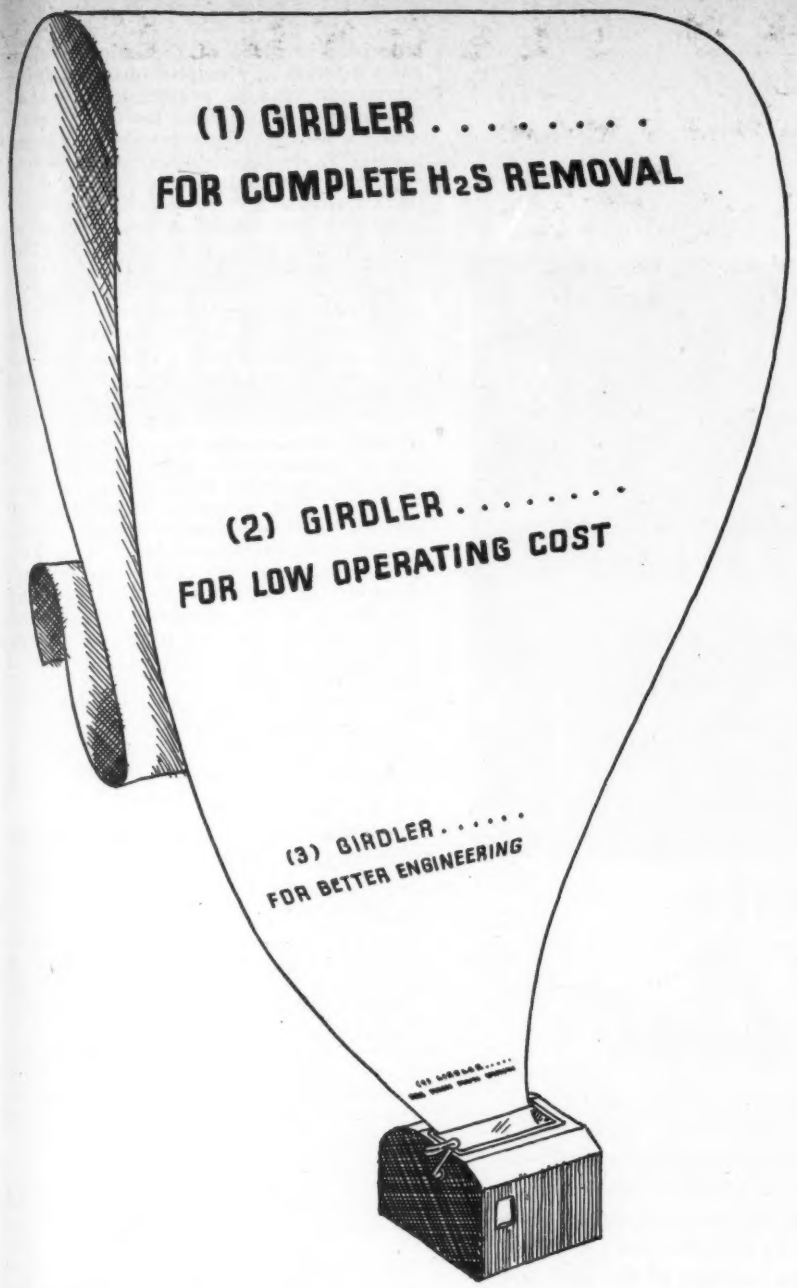
Furmural Solution Temperatures of Hydrocarbons. H. T. RICE AND E. LIEBER. *Ind. & Eng. Chem., Anal. Ed.* **16** (1944) pp. 107-10.

The solvency characteristics of various petroleum fractions such as solvent oil, solvent naphtha, Diesel fuels, gas oils, and the like, constitute an important index of the properties such products will show in use. The determination of these characteristics has been of some importance and several methods have been devised for their evaluation. Among these, those based upon the miscibility solution temperature of the oil and a liquid solvent are among the more important. The "miscibility solution temperature" is defined as the minimum equilibrium solution temperature for equal volumes of petroleum products and solvent liquid. Among the various solvents used have been aniline, nitrobenzene, benzyl alcohol, ethyl alchol, acetone and amyl acetate solution, and nitromethane. Aniline has been most generally accepted, although it has several undesirable properties. Aniline is a blood poison and its fumes are readily absorbed. Furthermore, it cannot be used for the determination of the miscibility temperature of fractions of high aromatic hydrocarbon content, because of its relatively high freezing point. The authors have studied the application of furfural for the determination of miscibility solution temperatures of petroleum fractions. Furfural is found to offer considerable promise; it is nontoxic and is directly applicable to petroleum fractions of high aromatic content, making possible elimination of mixed aniline point determination. Methods used in the work are described in some detail. Furfural points of various petroleum fractions are tabulated, and for comparison the aniline points are inculded. Since aniline is completely mixcible in petroleum fractions containing approximately 50% or more of aromatic hydrocarbons, it is necessary to employ the so-called "mixed aniline point" determination. This determination is a relatively complex procedure in comparison with the furfural miscibility determination, that can be carried out directly. A bibliography of sixteen references is included.

Chemical Compositions And Reactions

Synthetics for the Petroleum Industry. E. A. EVANS. *Jour. Inst. Petr.* **29** (1943) pp. 333-52.

The author reviews the subject of additives for use in modifying petroleum products. The most widely-known of these is tetraethyllead. The use of additives is practiced in many phases of the petroleum industry, and their use will grow. Additives for the prevention of gum formation and oxidation at atmospheric temperature include such effective compounds as pyrogallol, catechol, a-naphthol, p-phenylenediamine, p-aminophenols, and benyl p-aminophenol. Among the compounds suggested for neutralizing pro-oxidants may be mentioned disalicylethylenediamine. For prevention of the darkening of color tributylamine and triamylamine are recommended. The author discusses synthesis as applied in the production of additives and in general in petroleum technology. Addition reactions, because they are simplest, are considered first, including addition of hydrogen, oxygen, and sulphur. The addition of sulphur is used on a large scale in the sulphurization of cracked wax, fatty oils, fatty acids, etc., in the preparation of cutting oils and sulphur-containing lubricants. The addition of chlorine to various compounds is considered. By use of sulphur chloride both sulphur and chlorine can be added to the same molecule. Extreme-pressure bases have been made by treating fatty oils with sulphur mono-chloride. The chlorinated saturated long-chain hydrocarbons, found in paraffin wax, have found a ready market for incorporation in cutting oils and hypoid lubricants, and a still more extended use for them is envisaged. Nitration and sulphonation are briefly considered. The oxidation of petroleum hydrocarbons produces a dazzling array of alcohols, aldehydes, ketones, lactones, and acids, all possibly useful as starting-points in productive research. By using phosphorous tri-



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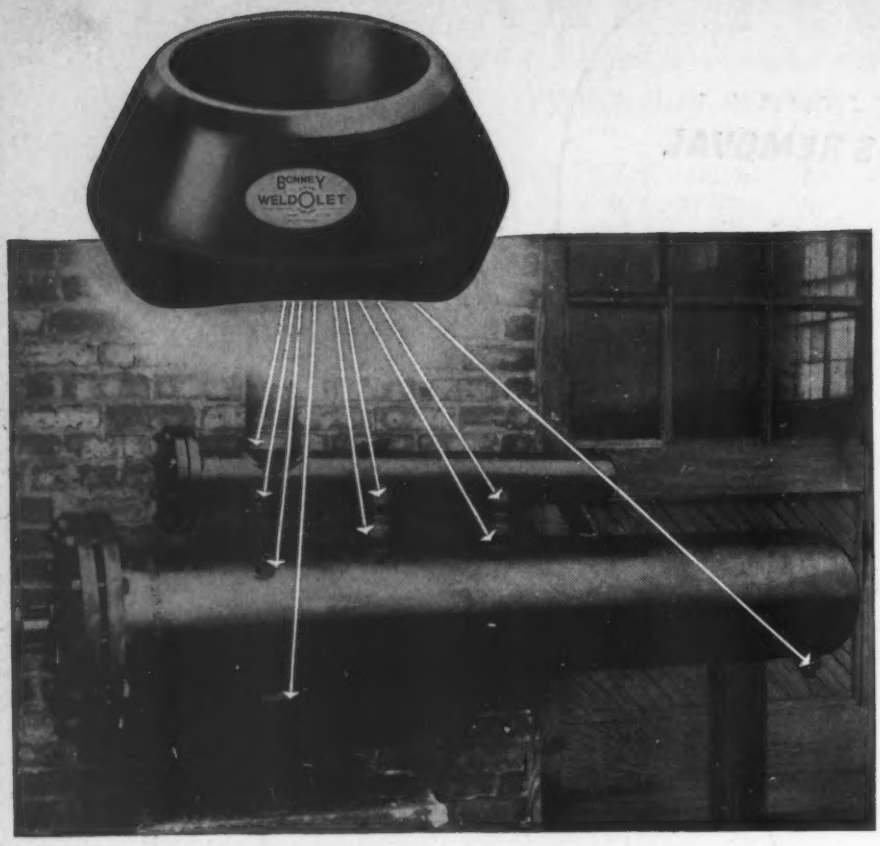

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chlorides in place of the sulphur chlorides a series of phosphorous-containing compounds can be prepared. Several illustrations are given, including reactions with alcohol, phenol, o-hydroxy acids, amines, and mercaptans. Several syntheses involving the removal of metal atoms are reviewed. Syntheses involving the condensation of chlorinated paraffin wax with aluminum chloride are considered. By the use of acyl chloride long chains can be added to complex aromatic compounds to give compounds such as derivatives of indene or coumarone. Condensation of ammonia with aliphatic alcohols has given us the valuable ethanolamines and their fatty acid salts and esters. Compounds such as the thiazoles are interesting, because they alone amongst the sulphur-containing compounds will protect cadmium bearings from acid attack. Complex organic metallic compounds are briefly considered. The ever-growing demand for less active and yet more active lubricants seems paradoxical, but it is nevertheless true. Lubricants must be resistant to attack, whether it be by oxidation, pressure or heat. The preferential destruction of part of the lubricant can be reduced by the imposition of barriers as through inhibitors or modifiers. A bibliography of 140 references, mostly to patents, is included.

Developments in Hydrocarbon Chemistry in Czechoslovakia. J. G. F. Druce. *The Industrial Chemist,* January (1944) pp. 20-22.

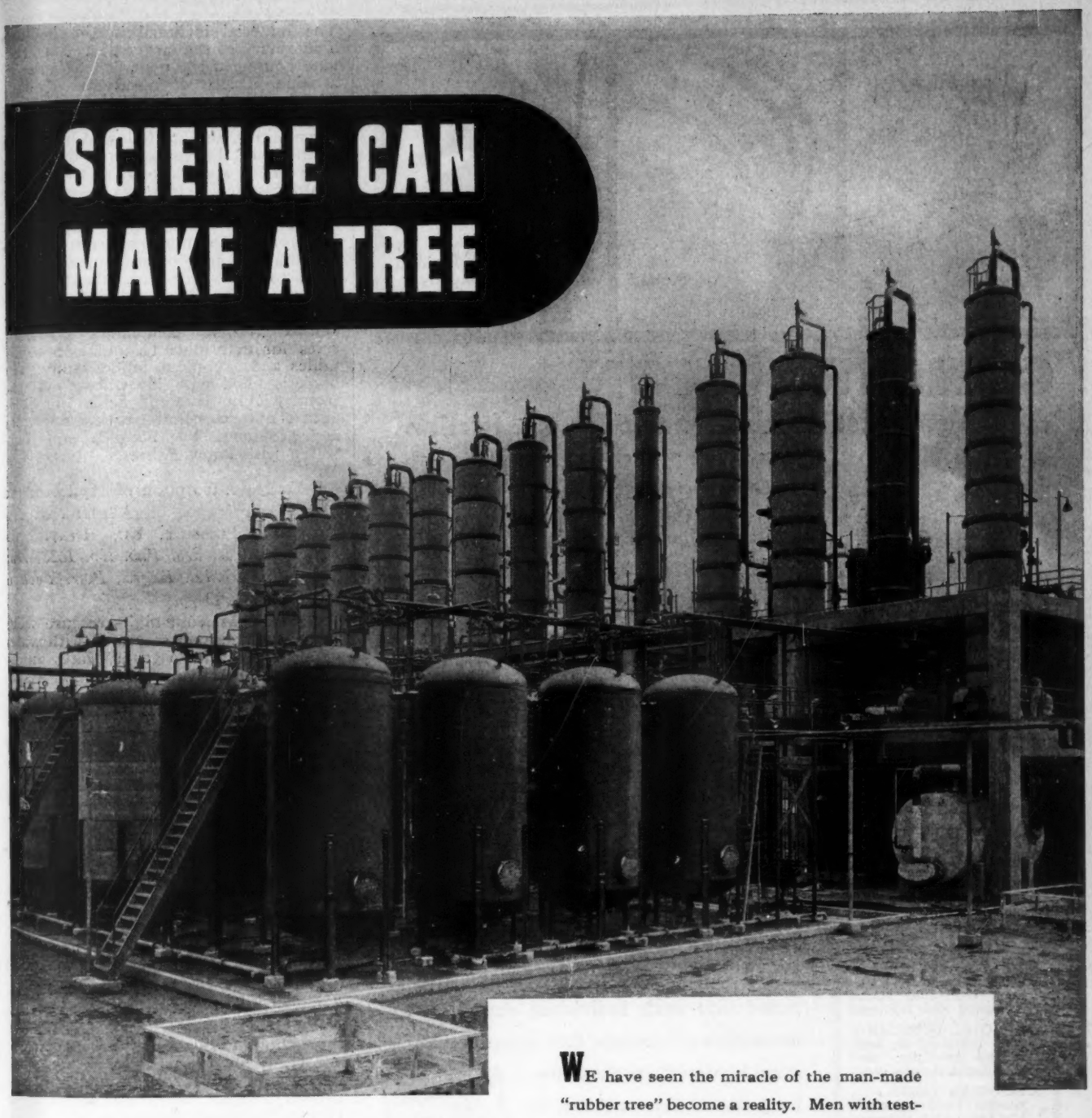
The author reviews petroleum chemistry in Czechoslovakia. The main lines of research were those on the higher paraffins and on the synthesis of alkyl naphthalenes. In addition there were investigations on butadiene derivatives as well as some with the netro-derivatives. Landa's method of synthesis of the paraffins consisted in treating esters of mono- and di-basic acids with Grignard's reagents, dehydrating the secondary alcohols so produced and then hydrogenating the olefines to paraffns. The highest hydrocarbon produced in this way was triacontane, $C_{30}H_{62}$. The higher hydrocarbons so synthesized are listed in the article. The oxidation of the hydrocarbons has been studied to a considerable extent, as well as the slow combustion to yield alcohols, aldehydes, ketones, acids and other products in smaller amounts. The naphthene hydrocarbons were also studied to some extent, snice they are contained in a Czechoslovak petroleum. Synthesis of several of these compounds is briefly described. Methyl-naphthalenes can be hydrogenated in the presence of nickel and similar methyl-hydro-naphthalenes result from ketone bodies on reduction. These substances resemble tetraline in character. A bibliography of seventeen references is included.

Manufacture: Processes And Plant

Treatment of Experimental Data. Archie G. Worthing and Joseph Geffner, John Wiley and Sons, Inc., 440 Fourth Ave., New York, N. Y., 1943. Price $4.50.

The use of the resources of numerical mathematics in the treatment of experimental results is a relatively new procedure in some of the fields in which experimental observations are made.

SCIENCE CAN MAKE A TREE



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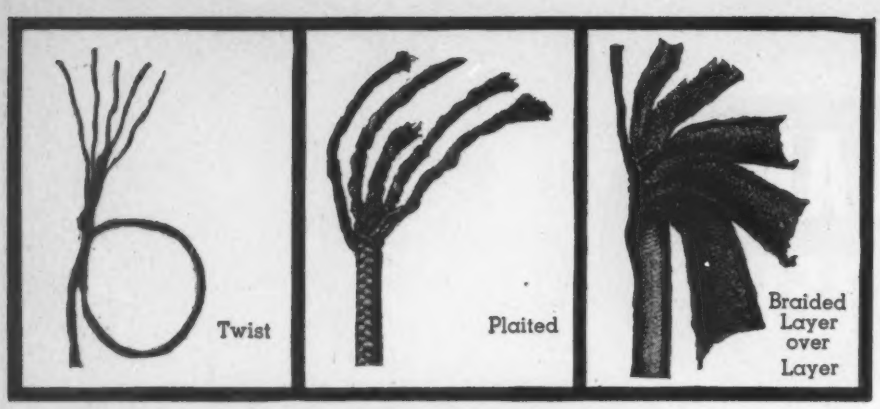

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The material included in the book is a summary of the larger part of a graduate course in the general treatment of a wide variety of observational data. The book comprises thirteen chapters. The first three pertain to primary representations, and are followed by one on methods of differentiation and integration. The applications and uses of Fourier series including a discussion of analyzers fill another chapter; following this is a discussion of normal frequency distribution, precision indexes and the technique of least square as applied to data. The final chapters contain an account of correlation and nonharmonic periodic functions, and an appendix gives the elementary expansion rules for determinants, and also useful tables and a copious bibliography. The book is filled with illustrative material from widely different fields of work, each chapter concludes with a summary and problems. The book is well illustrated with many figures.

Selective Adsorption of Hydrocarbon and Water Vapor on Alumina at Atmospheric Pressure. KU, HUNTINGTON AND REID. *Technical Pub. No. 1628, Am. Inst. Min. & Met. Engrs., Petr. Tech 6,* No. 6 (1943), 13 pp.

Natural gas from high-pressure wells leaves the reservoir saturated with water vapor and will form gas hydrates unless dehydrated. Activated alumina is a successful adsorbent of water, and can reduce the dew point 80 to 100° F., thus comparing most favorably with 45-55° F. reduction accomplished by use of diethylene glycol. In a typical plant operated at moderate pressure, 100 cubic feet of gas per day at a pressure of 1200 pounds per square inch, is dehydrated in four towers 3 feet in diameter by 28 feet high. Two of these are used while the other two are being regenerated by passing hot gas through the column of adsorbent at temperatures up to 300° F. The question has been raised as to whether the adsorption of hydrocarbons along with the water interferes with the adsorption of the water. The data obtained in the experimental work indicate that the adsorption cycle is divided into three phases; in the first of these, both water and hydrocarbon are adsorbed; in the second, water continues to be adsorbed but the hydrocarbon already adsorbed is stripped, and in the third phase the alumina is completely saturated with both water and hydrocarbon. In commercial practice the third phase is never reached. The results of the experimental work in general confirm commercial operation in that it was found that the dew point rises rapidly when the adsorbent approaches saturation, and that greater hydrocarbon recovery is had when operating with short cycles. The data given in the paper should prove useful in the design and operation of dehydration plants.

Bauxite as a Drying Adsorbent. W. A. LA LANDE, JR., W. S. W. MCCARTER, AND J. B. SANBORN, *Ind. & Eng. Chem.* 36 (1944) pp. 99-109.

Activated bauxite, especially the deironed Arkansas variety, is finding increasingly extensive application in all types of industrial drying. Among the several uses are the drying of the feed stocks to catalytic isomerization and alkylation plants, the dehumidifying of

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natural gas to prevent hydrate formation the protection of anhydrous organic chemicals from moisture, and the drying of gases for special purposes. Activated bauxite is durable and relatively inexpensive. It can be regenerated repeatedly, and its high efficiency and life make it comparable, even without consideration of the low cost, to other industrial drying adsorbents. The activation of trihydrate bauxites at temperatures up to 1600° F. was studied with particular reference to the production of a highly efficient drying adsorbent. Data are presented to show the relationship between activation temperature, residual volatile matter content, surface area, dry gas capacity, and equilibrium capacity. The mechanism of the thermal decomposition of bauxite is discussed with reference to the results of differential thermal and x-ray diffraction analyses. The maximum dry gas capacity is attained by activation at 700-750° F. This treatment reduces the volatile matter content of the mineral from 28-30% to 6-8%. Under optimum activating and operating conditions bauxite will adsorb 11-16% by weight of water before any moisture is detectable in the effluent. Activated bauxite can be regenerated repeatedly by heating at 300-500° F. Various other factors influencing drying efficiency are discussed.

On the Mechanism of Inhibitor of Styrene Polymerization. GOLDFINGER, SKEIST AND MARK. *J. Phys. Chem.* **47** (1943) p. 478.

In the use of inhibitors of polymerizathe questions arise as to how long a given concentration of inhibitor will prevent polymerization of the monomer, and, what influence has the inhibitor originally added on the course of the eventual polymerization and the quality of the polymer formed. The authors have studied the inhibition of the polymerization of styrene. Commercial styrene was twice distilled under vacuum and mixed with benzoquinone in amounts varying from 0.0025 to 0.050 weight percent. Twenty-gram samples of the material were sealed in tubes under nitrogen and heated at 70, 100.7, and 130° C. It was found that the length of the induction period and the amount of inhibitor added were roughly proportional. The inhibitor is used more rapidly at the higher temperature. It appears that little chain propagation or polymerization can occur until the quantity of inhibitor is small. The more inhibitor added at the start, the more the average molecular weight of the polymer formed, and the more chain-breaking substance resulting from the combination of styrene and quinone, was present.

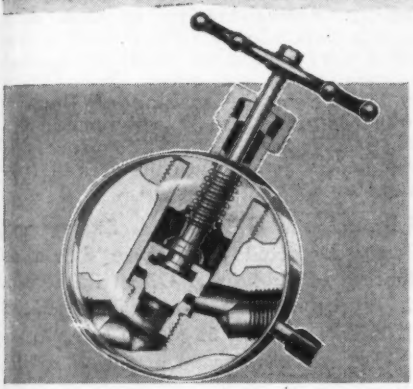
Styrene by Dow Process. *Chem. & Met. Pictured Flowsheet, Chem. & Meg. Engr.* **51** (1944) pp. 160-63.

Commercial production of styrene was begun by the Dow Chemical Company in 1935, and until the enormous demands of the Buna S program were felt, this company remained the only large-scale producer. At the present time the process is used in four Dow-operated plants and in part by two other producers, and is scheduled to supply about 90 percent of the styrene demands of the rubber program. The basic reactions are: The alkylation of

How to buy a Forged Steel Stop VALVE...

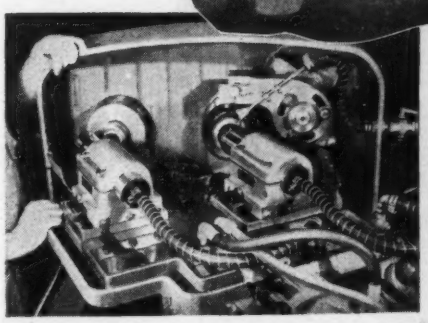
THERE'S more to buying a forged steel stop valve than a figure number, a price and a purchase order if you're interested in fitness for tough service and the real economy of long life and low maintenance. It's the important details of design, construction and processing of each material and part that makes the difference in forged steel stop valves.

Here's what to look for!



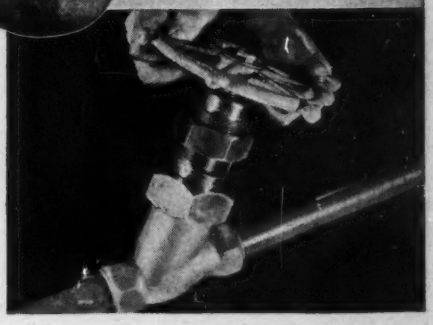
1 THE "WEAR ZONE"

Here's where a valve takes the most punishment. Edward builds extra life and extra protection against corrosion and erosion into this "wear zone" through EValloy stainless steel or Stellite seats and disks. Threads of both the seat and body are of the finest Class 4 commercial fit.



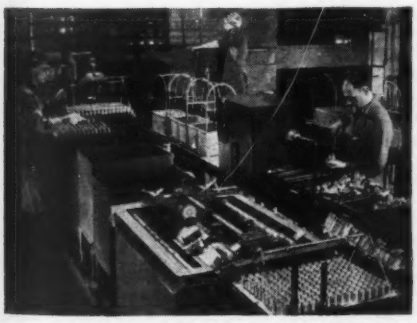
2 DROP TIGHT FIT

Seats and disks for Edward forged steel stop valves are precision borized in pairs on special machines (above). Mated seats and disks, absolutely concentric and smooth, show practically 100 per cent bearing surface when tested with blued gages. The result—drop tight valve closure.



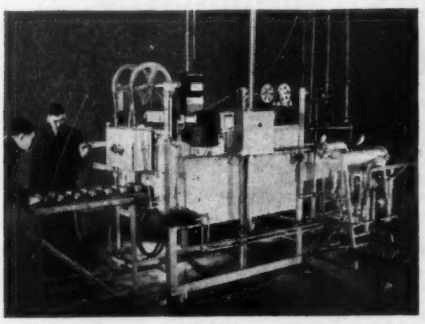
3 EASY OPERATION

Handwheels are mighty important. Handwheels for Edward forged steel stop valves are strong malleable iron, knobbed and easy to grip even with wet hands. Oversize dimensions facilitate operation. No other manufacturer puts larger handwheels on steel valves of like size.



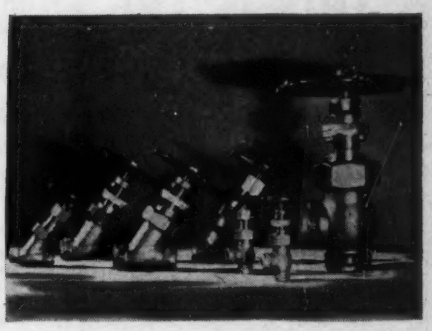
4 EVALIZED SURFACES

EValizing, the new exclusively Edward plating process, adds years of service to stem bearing surfaces, protects other exposed surfaces such as packing nuts, bonnets, junk rings, etc., against rust, corrosion and abrasion. Above, a section of the Edward plating department.



5 PROPER PROCESSING

Bodies, bonnets, seats, disks—all principal parts of Edward steel stop valves go right from the drop forge hammers to special furnaces, like the one above, for heat treatment under the control of Edward metallurgists for protection against indeterminate stress in service.



6 WIDE ADAPTABILITY

Globe or angle, inside screw or O. S. & Y., sizes ¼ in. to 2 in., screwed ends or ideally proportioned socket welding ends. But in every size and type, they're all steel, equal to any stress or strain. For illustrations, dimensions and concise data on the Edward line, write for Cat. No. 101.

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The body is forged steel; trim is 18-8 stainless. For special purposes, forged stainless steel bodies can be furnished. Made in standard sizes up to 2". For pressures up to 2000 lbs./sq. in.

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benzene with ethylene to form ethyl benzene, and the dehydrogenation of purified ethyl benzene to yield styrene. Ethylene and benzene enter a tower operating at essentially atmospheric pressure. In the presence of a catalyst alkylation takes place to form ethyl benezene, diethyl benezene, and polyethyl benzenes. The crude ethyl benzene so formed is then sweetened and distilled to give pure ethyl benzene. In this step the excess benzene is also separated and is then recycled. The polyethyls are returned for dealkylation to ethyl benzene. Ethyl benzene is dehydrogenated over a fixed catalyst in the presence of steam to give styrene and small amounts of benzene, toluene, and tar. In the distillation step these components are separated at reduced pressure to give recycle benzene, recycle ethyl benzene, a toluene by-product, and styrene of 99.5 percent of higher purity. The fractionation step is a delicate one because the difference in normal boiling points of ethyl benezene and styrene is only 9°C. Also, styrene polymerizes rapidly. Before loading in tank cars, styrene is cooled to 60° F. and a few parts per million of inhibitor against polymerization are added. In addition to its use in the making of Buna S rubber, styrene is used in the making of plastics. A flowsheet of the process is included, together with pictures of typical plants.

Bituminous Sands and Shales and Partly Depleted Subsurface Sands as Sources of Additional Oil in California. G. B. SHEA. *California Oil World and Petroleum Industry* **36 (1943) p. 9.**

The war has turned attention to the utilization of surface deposits of bituminous sands and shales, as well as to the more complete removal of high-viscosity oils from wells. Bituminous sandstones of the Santa Cruz Mountain region have been quarried for use as paving material in San Francisco and elsewhere. This material averages 14 to 15 weight percent crude oil. Sands in the San Luis Obispo region, comprising an area of approximately 50 square miles, have been estimated to contain one half barrel of oil per ton of sand. Investigation of these and other deposits is now under way by the Geological Survey and the Bureau of Mines. Processes proposed for the separation of the oil can be grouped into three classes: (1) separation by the action of hot water, with or without the addition of other reagents, (2) separation by the use of solvents, such as petroleum distillates, and (3) removel of the oil by distillation. The first method is undoubtedly the most economical. All enterprises that have been started to date have eventually been abandoned for economic reasons. Separation of the oil from the oil sands of the Athabaska region in northern Alberta is briefly discussed. The Canadian Government has studied the subject for a period of ten years. A plant has been built having a capacity of 400 tons of sand per day. This started operation in 1941. The process used involves the disintegration of the sand and its agitation with warm water. Since the specific gravity of the oil is nearly that of water, air is blown into the mixture, thus causing the oil to float to the surface in a froth. The froth is skimmed from the water and mixed with naphtha or a heavier petroleum distillate and heated to re-

"It might have been—"

We might have lost the war if the American refining industry operated on "trade secrets" instead of inventions that were disclosed and widely licensed, available to all

The petroleum refining art is an open book, written in the records of the United States patent office

Safeguarding the rights of inventors for the limited period of 17 years, constitutes the backbone of steady progress Disclosures by one inventor spur the efforts of many others

American refiners could not have done so good a job so quickly except for our patent system, which protected the results gained through many years of expensive pioneering, research and development Fortunately, the industry was prepared and will eagerly continue to meet any emergency necessary to lick the enemy

Our fighting men will not lack aviation gasoline or other vital oil products on any front

CATALYTIC CRACKING	HYDROFORMING
REFORMING	DEHYDROGENATION
HYDROGENATION	POLYMERIZATION
ALKYLATION	UNISOL TREATING
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Fig. 16
"Renewo" Globe

Fig. 1640
"King-clip" Gate

Fig. 2125
Bronze Gate

In the heavy duty that Lunkenheimer Valves are doing on every front—industrial, maritime, army and navy, chemical, petroleum, synthetic rubber—a prime attribute is lasting quality . . . that inherent quality that comes of correct engineering, simplicity of design, and "know-how" manufacturing born of long experience.

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SIMPLICITY OF DESIGN
MEANS EASIER MAINTENANCE

Fig. 1430
Iron Body Gate

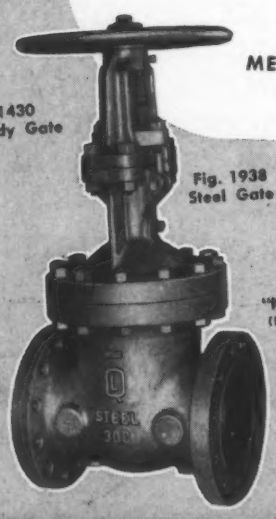


Fig. 1938
Steel Gate

Fig. 123
"N-M-D" Globe
(Non-Metallic Disc)

BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S.P.;
BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

duce the specific gravity and viscosity of the oil layer, thus making gravity separation possible. The diluent is recovered in the course of refining the oil. The success of the process is dependent upon freshly mined sands, since exposure to air modifies the properties of the sands.

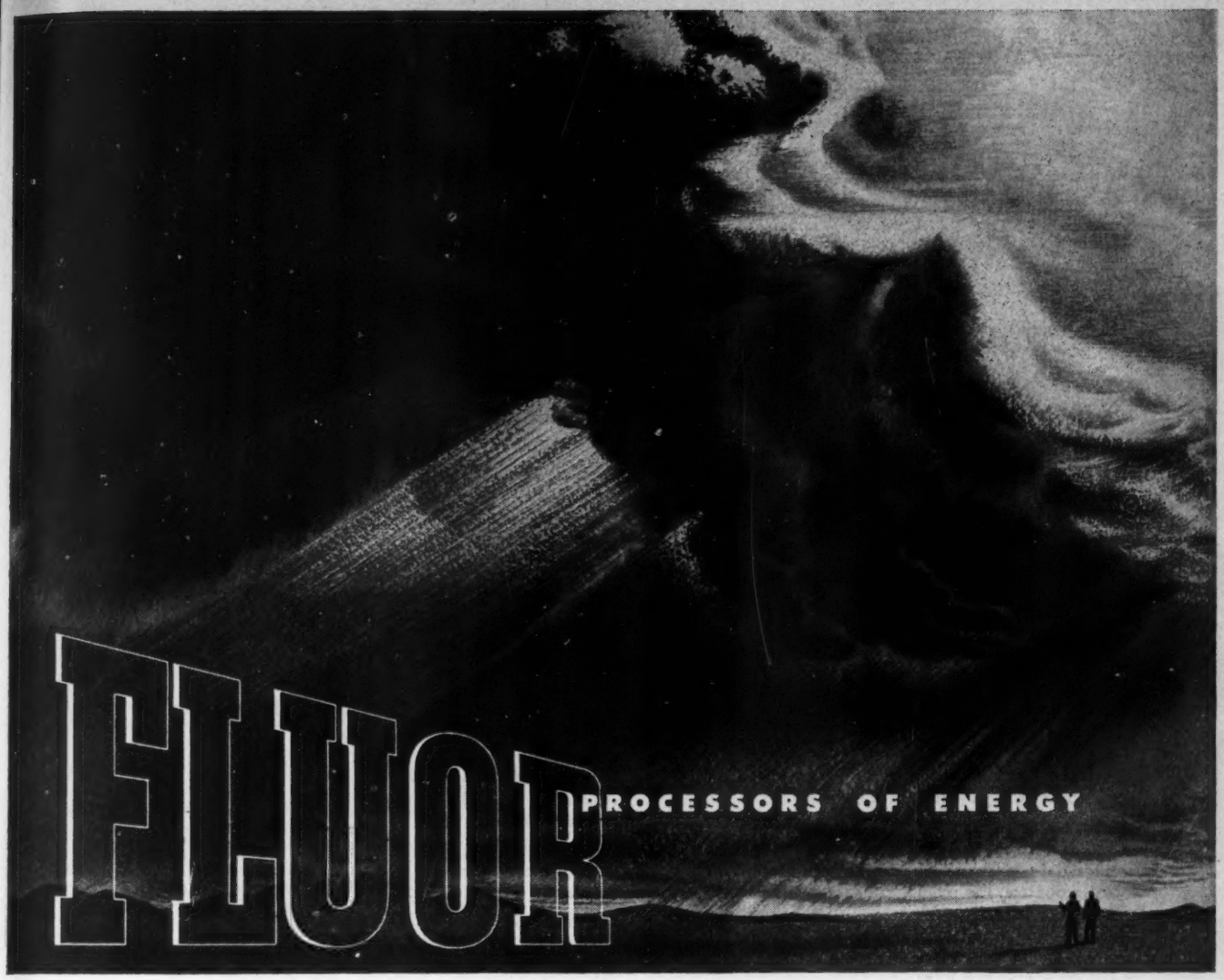
Asphalt from the Alberta Tar Sands. J. H. HOLLOWAY. *Roads and Bridges* (1943) pp. 78-86, *Mar. Quarterly Digest of Cur. Asphalt Petroleum Literature,* April (1943).

The largest single natural source of oil in the world is the "tar-sand" field of Northern Alberta. This covers an area of at least 10,000 square miles, located near the junction of the Athabaska and Clearwater rivers. It is estimated by government authorities to contain three to seven times as much oil as the total of all the other proved reserves of oil in the world. However, probably not more than one-half of one percent of this deposit is commercially available at present-day costs and prices. This is occasioned by the fact that the oil-bearing sands lie at a depth of 500 to 1800 feet below the general surface of the ground. The oil cannot be recovered through wells because it is too viscous to flow readily and too closely associated with the sand grains to drain into wells. It is only where the sands are exposed at the surface that it is practical to recover the oil. Experience has shown that in the case of the surface deposits the richer beds are found at the base of the deposit. The sand itself is mainly quartz with some mica. At present the mining is by open-pit method, or quarry. Separation of the oil by the hot-water method has been well tested and is at the present time proving its worth in a plant that has a capacity of 600 tons of oil-sand per day, yielding about 550 barrels of oil. The asphalt obtained from the oil has a 15 penetration and a ductility of 150. The Dominion government is at present extensively investigating the possibility of the further development of the field.

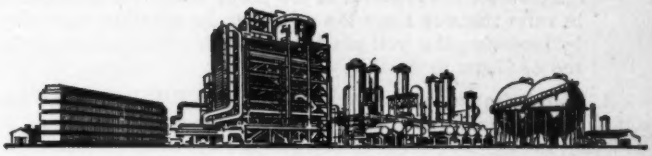
Products: Properties And Utilization

Practical Cutting Fluid Recommendations for Use with High-Speed Steel Tools. BOSTON, MOIR, SLAUGHTER AND OLDACRE. *Mech. Engr.* **65** (1943) p. 889.

Sulfurized cutting oils tend to stain nonferrous metals, such as copper and copper alloys. Carbon tetrachloride, chloroform and other volatile solvents should not be included in cutting fluid composition because of possible harmful physiological effects. In the machining of aluminum, cutting oils are diluted extensively with kerosene or mineral seal oil. Kerosene is added to emulsions to improve the surface quality of machined aluminum. Machining of magnesium alloys is usually effected with mineral seal oil except when it is desirable to machine dry. In machining dry it is necessary to use a cutting fluid as a coolant, and to apply an oil for lubrication. The oil should be a light mineral oil properly blended with 10 percent of a fatty oil. In machining monel metal it is found that an emulsion gives a longer tool life than sulfurized oil. Cutting fluids should be applied in large quantities at the highest velocity possible without splashing, and



Our business starts with molecules. It transforms into useful products and services the untamed forces of nature. It employs the power of the wind, the sun, the rain, the lightning. It unleashes the available energy packed into a drop of crude oil and transforms it into power to travel the stratosphere... into heat for factory furnaces and warmth for homes... into synthetics for making rubber, plastics, explosives, paints, perfumes, cosmetics... a whole host of modern servants. Wherever the energy latent in air, water, fluids, vapors or gases can be processed and put to work, Fluor provides a comprehensive service ...complete from plan to plant.



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No. 587

125-pound valve power operated by diaphragm motor. Declutching unit and hand wheel for use in emergencies.

While the majority of R-S Butterfly Valves are manually operated, they are also adapted to power operation. In such power installations, the inclusion of the R-S declutching unit (patent pending) and hand wheel has *four advantages.*

In the first place, if it is desirable to install a manually controlled valve and, at a later date, it becomes advisable to obtain some type of prime mover for automatic control, the prime mover can then be installed in the field.

If the delivery date of the prime mover can not be made to coincide with the delivery of the valve, the valve can be installed and operated at once by hand.

A power failure will cause a power operated valve to be inoperative. Such is not the case, however, when a declutching unit and hand wheel are provided.

Likewise, the removal of the prime mover for maintenance, does not result in valve inaction since the valve can be operated manually at any time simply by removing the pull pin from the link which connects the diaphragm reach rod or piston to the link.

Investigate the many advantages of R-S Butterfly Valves **(15 to 900 psi)** and especially the merits of the R-S declutching unit and hand wheel.

VALVE DIVISION

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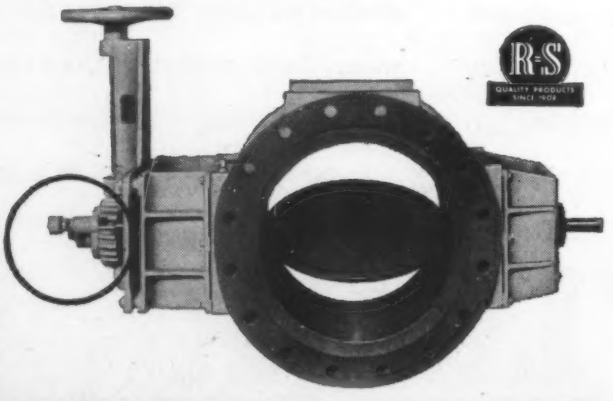


No. 588

125-pound valve with two outboard bearings and hand wheel control with declutching unit. Note absence of power operator which will be installed after the valve is placed in operation.

R-S Streamlined BUTTERFLY VALVES

directly on the tool point where the chip is formed. Three to 5 gallons per tool point should be effective. The temperature of the cutting fluid should not be over 100° F.

Definitions for Waxes, Etc., Derived from Petroleum. Report by the Nomenclature Panel of Standardization sub-Committee No. 8—Petroleum Waxes. *Jour. Inst. Petr.* **29** (1943) pp. 361-3.

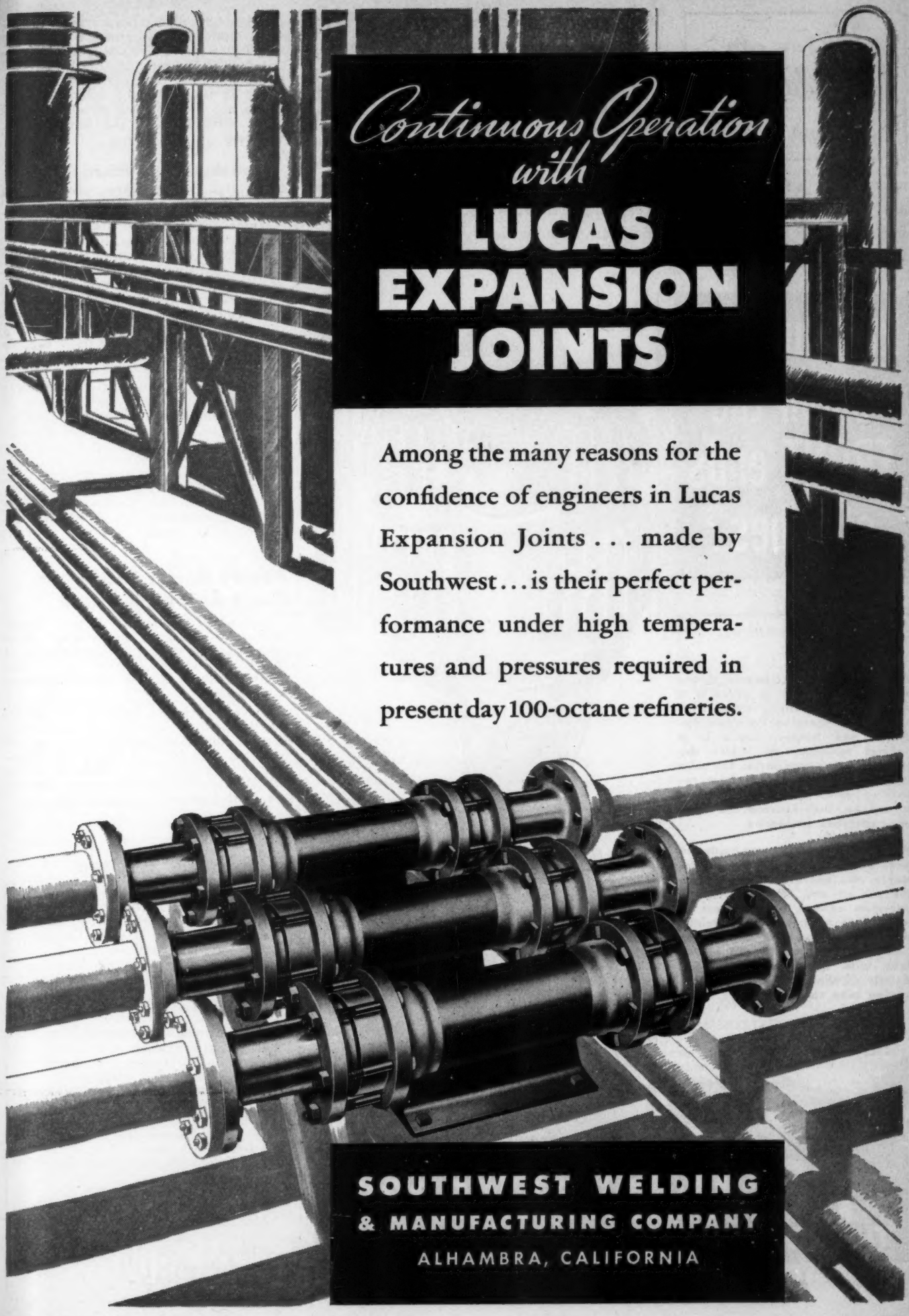
Petroleum waxes are divided, mainly on the basis of crystal size, consistency, and method of manufacture, into three groups, the "paraffin wax" group, the "petrolatum" group, and the "petroleum ceresin" group. The latter two groups include the waxes previously classified as "microcrystalline" or "amorphous." Definitions are included for scale wax and refined paraffin wax in the paraffin wax group, for petrolatum wax and petroleum jelly or petrolatum in the petrolatum group, and for the waxes included in the petrolatum ceresin group. The ceresin group waxes are usually derived from residues, are esentially free from oil, and are hard and brittle. They vary in color from dark brown to white. Molecular weight ranges from 450 to 1000, and the setting point is usually above 160° F.

Improved Fractionating Column for Gases. H. S. Booth and R. McNabney. *Ind. & Eng. Chem., Anal. Ed.* **16** (1944) pp. 131-33.

An improved automatic fractionating column for low-boiling gases is described, which, it is claimed, is of greatly improved efficiency and is capable of precise temperature control over a wide temperature range at least up to 10° C. The column is of the constant-pressure type in which the pressure is maintained by controlling the cooling of the still-head condenser by a contacting manometer connected to the still head. Its control is so delicate that liquid air has been used as the refrigerant successfully to distill fractionally a gas boiling at +8° C. without freezing the head and with the temperature holding constant. Details of the construction of the column are given, and the method of operation is also described.

Correlation of I. P. Lovibond and Saybolt Chromometer Colour Measurements on Motor Fuels and Refined Petroleum. Report by the Colour Panel of Standardization Sub-Committee 3—Liquefied Petroleum Gases, Gasoline, Kerosine, and Distillates. *Jour. Inst. Petr.* **29** (1943) pp. 357-60.

Two methods for determination of the color of motor fuels and refined petroleum oils are described in Standard Methods for Testing Petroleum and Its Products (1942 Edition) — namely, by the Lovibond Tintometer, using the 18-inch cell and by the Saybolt Chromometer. It is often desirable to be able to convert with approximate accuracy readings obtained by use of one instrument to the corresponding readings of the other. The Color Panel of Sub-Committee No. 3 of the Institute of Petroleum Standardization Committee started to make a series of determinations of colors by both methods on a range of typical products, using as many instruments and operators as were available to the Panel. Twenty-two samples were



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Yes, we can fight a cheaper war

The other day we were watching a news reel showing an American landing party approaching Jap occupied shores. It sure was comforting to see that we had enough stuff there to plow up every square inch ashore with hot steel from the guns of our landing barges and warships. It must have cost plenty to fire all that stuff, but would any of us say, "Let's shoot less and save some of that money," especially if one of our loved ones were in that party? Here was a graphic example how money saves life—money we invest in War Bonds. The Roto Company, Newark, N. J.

Do your men clean the FRONT ends of tubes?

With ordinary tube cleaners, cleaning the front ends of tubes is a dangerous operation, even with perfect coordination between operator and helper. There is a natural tendency to insert the cleaner far enough inside the tube to eliminate any danger from revolving cutters when the air is turned on, thus leaving the front ends of tubes uncleaned.

With a Roto Tube Cleaner equipped with air valve directly behind the motor, the operator himself turns the air on and off. This positive one-man control permits him to turn on as much air as he needs, whenever he needs it, and he can clean right up to the end of the tube with complete safety. Get details of these time- and labor-saving tube cleaners.

ROTO Tube Cleaners

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circulated to nine laboratories. The results obtained are summarized in tables, and a curve is given showing the relationship of the readings of the two instruments. Six precautions to be followed in the taking of color measurements are given, most of which apply more particularly to the Lovibond instrument.

Photoelectric Photometry. R. H. HAMILTON. *Ind. & Eng. Chem., Anal. Ed.* 16 (1944) pp. 123-6.

Numerous photoelectric devices are used in laboratories throughout the country. Most of them, such as photoelectric colorimeters, are used for measuring the relative amount of light transmitted by a given depth of colored liquid in order to determine the concentration of solute that absorbs light of a certain wave length. The light used in the measurement is restricted to more or less narrow bands by the use of filters, prisms, or gratings. Measurement is effected by reading the deflection of a galvanometer caused by a photoelectric cell, or by use of a potentiometer to balance the circuits of two photoelectric cells. The sources of error in measurements of this type are discussed. For maximum accuracy conditions must be so chosen that readings of transmitted illumination fall on the central portion of the scale.

Pauley Heads Pacific Coast Asphalt Institute

Harold R. Pauley of Petrol Corporation, Los Angeles, was elected chairman of the managing committee of the Pacific Coast division of the Asphalt Institute, at the annual meeting March 23.

Eleven of the 38 companies comprising the institute are Pacific Coast marketers. The Los Angeles meeting was presided over by J. A. Blood of Standard Oil Company of California, retiring chairman of the executive committee of the national organization.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, Thirty-third, Federal and Dearborn Streets, Chicago, Illinois, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only in one gram quantities, please inform the registry.

Straight-chain organic acids of 35 to 45 carbon atoms
1-Amino-2,3-Hydroxy propane
t-Butyl lactate
Cadion 2B (4-nitro-1-naphthalene-diazo-p-amino azobenzene)
di-lauryl phosphate
Di-n-hexylamine (10 lbs.)
3,4-dibrom-hexane
3,4-dibrom-hexene
3-Hexine
3-Hexene
Methyl fluoride
Methyl, dimethyl, ethyl and diethyl malononitriles
Phenyl acetone
Propiolic acid
2,2′,2″-Tripyridyl

Are you using
ANHYDROUS HCL
in the production of

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- SYNTHETIC RESINS
- VINYL CHLORIDES
- PHARMACEUTICALS
- AMINE HYDROCHLORIDES

HERE'S A NEW WAY TO PRODUCE 99+% HCL RIGHT IN YOUR OWN PLANT

As a contribution to American Industry...

...an unrestricted and royalty-free license will be granted to any company wishing to manufacture anhydrous HCL with chlorosulfonic and muriatic acids.

SIMPLICITY describes this new Du Pont process.* No other process for producing anhydrous HCL in moderate quantities costs so little to install—or is so safe, easy and economical to operate. By direct reaction—without supplementary purification—you get 99+% HCL. The by-product is 66°Bé sulfuric acid—a strength readily usable or salable.

If you're now using as little as 50 pounds of anhydrous HCL daily, a unit can be designed which will pay for itself in less than a year.

For further details of this process and for information on chlorosulfonic and muriatic acids write: E. I. du Pont de Nemours & Co.(Inc.),Grasselli Chemicals Department, Wilmington 98, Delaware.

*U. S. PAT. NO. 2,303,537

QUICK FACTS ABOUT THIS NEW PROCESS

Low investment: Much of the necessary equipment may already be available in your plant. Only standard materials of construction are required.

Simplicity of operation: Occasional adjustment of but *one* valve is all the control required. Process can be started and stopped at will.

Low operating cost: Power consumption is negligible. Operation requires part-time attention of only one man.

By-product: Approximately two lbs. of usable or salable 66°Bé H_2SO_4 per pound of HCL are obtained.

High purity yield: 99+% Hydrogen Chloride.

TYPICAL ANALYSIS OF DU PONT CHLOROSULFONIC ACID

Specific gravity @ 60°F.	1.752
Total chlorosulfonic acid ($HClSO_3$)	98.8%
Free sulphuric acid (H_2SO_4)	0.7%
Iron (Fe)	0.001%
Boiling point	316°F. (Approx.)
Freezing point	-112°F. (Approx.)

DU PONT CHLOROSULFONIC ACID

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

NEW EQUIPMENT FOR THE MODERN PLANT

Glass Tower Packing

Owens-Corning Fiberglas Corporation, Toledo, Ohio, is providing a fiber glass for tower packing in chemical processing. The material now is in use in alcohol distillation columns and it is recommended for petroleum and natural-gasoline processing.

Glass fibers used in tower packing average approximately .0080 inches in diameter. They are arranged in jackstraw manner and bonded together with a special fugitive binder. Packs are made in two standard sizes — 20x20 inches, 1 foot, and 20x25 inches, 1 foot. Average density is 3½ pounds per cubic feet. Single packs have approximately 135 square feet of surface area per cubic foot of material.

The amount of free cross-section affects the frictional drop through the tower, as well as the force required to send the vapor up through the column. At 3½ pounds density and at a vapor flow of 5 feet per second or greater the resistance of fibrous glass tower packing is approximately 1½-inch water gauge per foot of material.

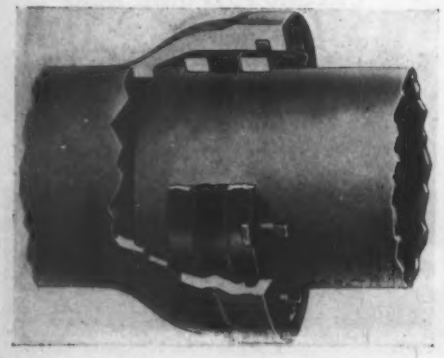
Percentage of volume of glass fibers packed at 3½ pounds per cubic foot is only 2.25 percent, leaving free volume of 97.75 percent. The amount of liquid retained varies with the viscosity of the liquids involved but in all cases the amount of liquid retained by fiber-glass packing is small.

Fibrous glass tower packing has adequate mechanical strength for normal handling and application. Packs are constructed in easily handled units for installation. Their compressibility allows excellent joints to be formed so vapor by-pass areas are avoided.

Joint for Cast-Iron Pipe

Dresser Manufacturing Company, Bradford, Pennsylvania, again is offering its Style 85 Bellmaster Joint for cast-iron pipe. This item was introduced in 1941 but war conditions prevented cast-iron pipe manufacturers making the required pipe and it was necessary to withdraw the joint from the market. This situation having improved, both pipe and joints now are promptly available, the manufacturer says.

This mechanical joint for cast-iron pipe consists of rings and cap-screws which compress a resilient gasket against the pipe to effect a tight and flexible seal which absorbs expansion, contraction, deflection, vibration and other stresses and strains. The inner circumference of the special pipe required is grooved to accommodate the locking lugs, and slots on the face of the bell permit lug passage.

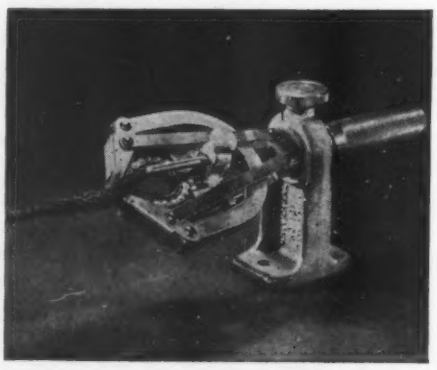


Dresser Style 85 Bellmaster Joint

Packing a distillation column with fibrous glass packs. The packs can be installed up to 70 percent faster than other materials used for this purpose.

Cable Splicer

Mechanics Engineering Company, Box 243, Jackson, Michigan, has developed the improved Universal Splicer for splicing wire cable. The device facilitates splicing by holding cables firmly in the proper position on thimbles or bushings. The sprocket chain adapter is built in, and is instantly adaptable to any size and type of cable from 1/16- to ¼-inch diameter, using either thimbles or bushings.



Universal Cable Splicer

The adapter insures good work by providing a firm hold. The sprocket chain automatically grips and snugs the cable around the thimble or bushing when the jaws close, effectively preventing any bulging of the cable strands.

For production jobs the stand of the splicer should be bolted to a bench. For maintenance work the splicer can be removed from the stand whenever necessary or desirable, and held in a vise.

For emergency jobs or whenever it is not convenient to use either the stand or a vise, a workman can hold the splicer.

The splicer can be used on jobs where turnbuckles, couplings, or special fittings have been linked with thimbles or bushings.

Conveyors

Chain Belt Company of Milwaukee announces a conveyor-elevator system to be known as the Rex Uni-Flo, for the mass handling of free-flowing bulk materials.

The Rex Uni-Flo is a conveying unit of the continuous-stream type. It is composed of a chain-belt-equipped closely-spaced scraper-carrier flight, which operates in an enclosed casing. With the entire cross section of the casing and all the space between the flights solidly filled with the material being handled, a continuous flow of material results.

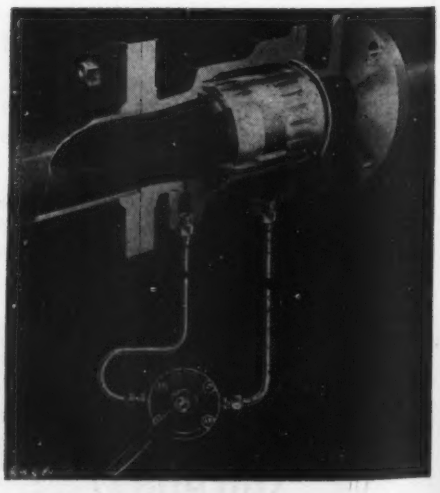
It has a positive and unique discharge mechanism that definitely removes all material in the conveyor system at the point of discharge. It is completely self-feeding and no auxiliary feeding devices are required. The unit is self-cleaning and has a minimum of churning and degradation of materials either while in operation or after the feeding has stopped.

Rex Uni-Flo is flexible in application with a wide choice of basic units and few limitations as to layout. It can convey material horizontally, vertically, or at any angle. It offers a direct line of transportation by the shortest possible route to conserve valuable productive space. Because it is essentially a closed-circuit method of handling, it is clean and dust-free.

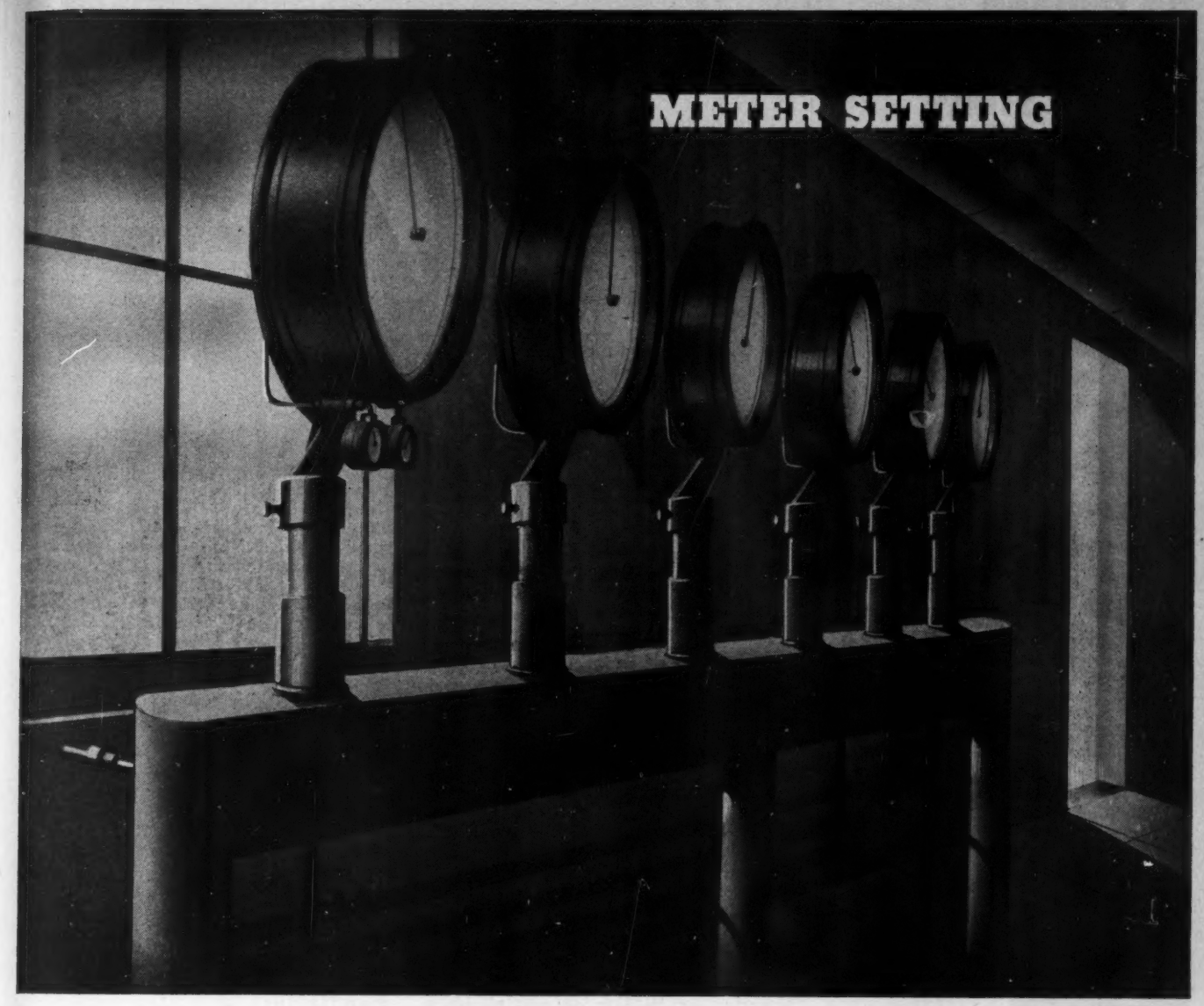
Remote Control Valve

Grove Regulator Company, 6567 Green Street, Oakland 8, California, has developed the Grove Flexflo Remote Control Valve. Identified as an "expansible tube type," the valve operates by manual or automatic remote control on the hydraulic principle of balanced and unbalanced fluid line pressure. So little force is required to operate the valve, according to the manufacturers, that a large 24-inch valve can be opened or closed as easily as a 1½-inch.

Designed for cold fluid service, the valve is especially suited for handling oil, gases, salt water, water, air or chemical solutions. Since one non-metallic operating part only is utilized in the



Grove Valve



Information supplied by "Petroleum Refiner"

Meter installations in pump rooms may be kept free of vibration as well as convenient by providing an angle iron mounting with posts supported in concrete. Length of the mounting and the number of supports is determined by the number of recording instruments essential to the delivery and transfer of refinery materials.

Holders for the meters are provided by welding two-inch collars to the flat side of the angle iron at regular intervals. Nipples and mounting heads of the meters can be set up in these collars as desired.

For convenience, these mountings should be installed far enough from the pump house wall to permit meters to be serviced from the back. This space also allows ample room for cleaning instruments as well as the floor and wall.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

500 Fifth Avenue • New York City

MOLY

NO MIRROR NEEDED for the atc STORY BEHIND this PANEL

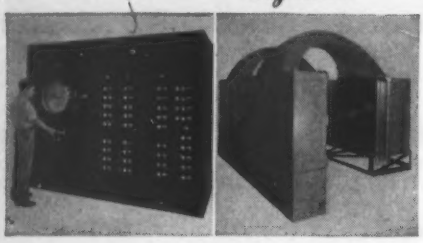
HERE IT IS . . .

The distinctive feature of the Houdry process, which is in operation in the Sun Oil Co. plants at Marcus Hook, including the new $13,000,000 plant dedicated last week, is an automatic timing device, which controls the cycles of the catalytic action which break down various charging stocks, including straight run gasoline, into the powerful fuel essential to the operation of military aircraft.

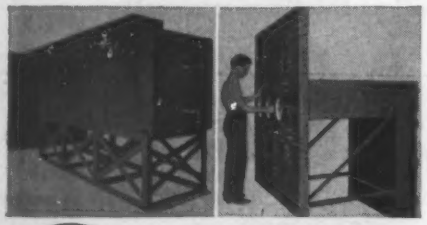
So completely does the automatic timing device control the process, that a crew of five is all the labor that is needed to operate a unit with a capacity of 1000 barrels of gasoline an hour.

J. C. O'Brien, *Phila. Inquirer*

atc *Dependable* PROCESS TIME CONTROL *Systems*



The illustrated Time Controls (largest built!) represent only a few of the ATC Timers now controlling 100-Octane Gasoline and Butadiene processes. For accurate control of sequence and duration of from 1 to 1000 consecutive and overlapping machine or process functions, investigate the ATC Line. Complete standard line of Industrial Time Controls, as well as Systems for special requirements, built to "specs" or entirely factory-engineered.



atc

Process Engineers write on your letterhead for file data on ATC Cycle Control Timers.

AUTOMATIC TEMPERATURE CONTROL COMPANY, INC.
34 E. LOGAN STREET, PHILA. 44, PA.

construction, the valves offer maximum resistance to corrosion and erosion as well as electrolytic action, and are said to be automatically self-compensating for wear.

Four parts make up the valve assembly: the valve head, the flange head, a slotted pipe-like core with a solid barrier in the center, and a cylindrical flexible tube. This resilient tube is stretched tightly over the core. The tube and core slip into the valve body as a unit and are firmly held in place by the bolted flange head. The flanged ends of the tube serves as a leak-proof gasket sealing off an encircling pressure chamber from the flow stream. Existing fluid pressure in the line forces the tube to fully expand against the inner wall surface of the encasing valve body, thereby opening the valve and permitting a constantly smooth streamline flow. This occurs when the remote-control valve is closed. By opening the small remote-control valve, line pressure is diverted into the actuating chamber and establishes a pressure balance on the inner and outer walls of the expansible tube. The tube then "flexes" closed over the surface of the core. Static line pressure then maintains a positive, bubble-tight, air-tight shut off of the valve indefinitely.

The valve requires no more head room than a pipe. Several valves can be controlled from a central remote-control station, and can be operated hydraulically or pneumatically by various systems such as manual, electro-solonoid, mechanical or automatic remote control.

Hydraulic Loader

Anthony Company, Streator, Illinois, announces a hydraulically operated device known as the "tailgate loader." This mechanism is said to make it possible for one man to load or unload from platform or truck or van bodies, heavy awkward bodies that usually require several men to handle.

One lever controls the lift, raising, lowering or holding at any elevation. When the body being raised is in a raised position, the entire mechanism locks.

The 5-inch hydraulic cylinder stops automatically at the ground and body level, and is capable of lifting from 750 to 1500 pounds according to the various models.

Ridgid Strap Wrench

Ridge Tool Company, Elyria, Ohio, has added a strap wrench to its line of wrenches. The strap wrench is made with an I-beam handle and solid head in one piece, with a handy hang-up hole in the end. The special webbing strap is quickly removed for replacement by pushing out a pin held by spring clips.

Ridgid Strap Wrench

The wrench is made in two sizes: No. 2, capacity, ⅛-inch to 2 inches, with a 17-inch strap; No. 5 capacity 1-inch to 5 inches, with 30-inch strap.

Water-Soluble Cellulose

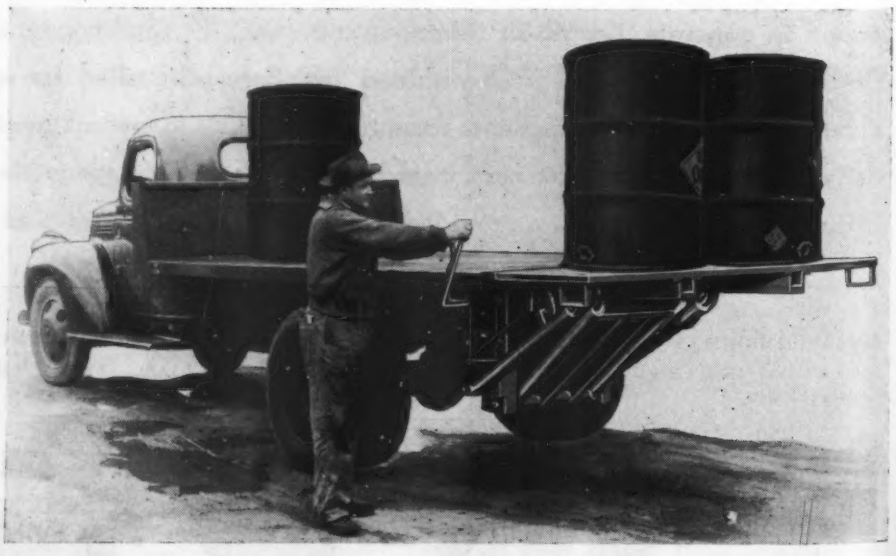
Hercules Powder Company, Cellulose Products Department, Wilmington, Delaware, has introduced sodium carboxy-methyl-cellulose, a cellulose derivative which is soluble in water. Experimental research is being conducted to determine the suitability of the material in the manufacture of emulsions, paints, textiles, oil and other industries.

Now in small-scale production, the chemical is available in experimental quantities only. Properties of sodium carboxy-methyl-cellulose make it a stabilizer and emulsifying agent.

"The material should be useful where hydrophilic colloids possessing marked suspending, thickening, stabilizing and film-forming properties are required," the company says. "Some of its possible applications are to thicken textile printing pastes, to emulsify emulsion paints and lacquers and to provide a protective colloid for oil-in-water emulsions.

"Its film-forming properties make it useful in coatings, particularly for greaseproof coatings. Other uses for the water soluble colloid are in the manufacture of boiler compounds, creaming latex, oil drilling muds, ceramics, can-sealing compounds, anti-stick compounds, leather finishes and many other industries.

"Sodium carboxy-methyl-cellulose is supplied as a white, granular powder, odorless, tasteless and readily soluble or dispersible in water. Very viscous,



Anthony Hydraulic Loader

20 Years OF SERVICE

On this, our birthday, we want to thank you, our customers and friends, whose loyal support and cooperation have contributed so vitally to the welfare of the Maintenance Engineering Corporation. We shall try to merit the continuance of the confidence you have shown in us during the past 20 years.

Thank You!

DIRECTORS

C. E. NAYLOR
W. J. PEDDIE
W. B. RAWSON
A. J. HOOPER*
C. W. GAUTIER
B. I. THORNGREN

*Captain, USMCR, on duty in South Pacific

MAINTENANCE ENGINEERING CORPORATION

3611 CLINTON DRIVE, HOUSTON, TEXAS

MECO

EQUIPMENT WITH ENGINEERING SERVICE

Use the **Load Lugger System** *of* **SLUDGE HANDLING**

FIRST:
Fill buckets at tanks as shown. Hook on hoist and raise bucket onto Load Lugger.

THEN:
Haul loaded bucket to sludge pond and dump it automatically. An easy, clean, economical method.

"Action Shots" of
BROOKS LOAD LUGGER

Write for this Folder Today

This is the practical answer to your sludge problem . . . it's faster, cheaper and it saves manpower. Load Lugger unit mounts on truck chassis. Use several detachable "bodies" or dump buckets for handling sludge or any other materials. Leading oil companies find this is the ideal method to use at refineries, marine terminals and storage yards.

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Steelcrete

EXPANDED METAL *For All Purposes*

THE CONSOLIDATED EXPANDED METAL CO'S
WHEELING, WEST VIRGINIA
Offices in Principal Cities • It's Wheeling Steel!

stable aqueous solutions can be obtained with it. Aqueous solutions can be evaporated leaving colorless, tough, transparent films which are unaffected by the common organic solvents, oils, fats and greases. Some salts and acids react with sodium carboxy-methyl-cellulose producing films insoluble in water."

Tables and data have been prepared by the company showing viscosity, effects of salts and acids, compatibility with various materials and physical, chemical and other properties.

Unlike nitrocellulose, cellulose acetate, ethyl cellulose and most other cellulose derivatives used as industrial materials, it is soluble in water. It is this property upon which its principal value in industry is based.

"This is the newest of the compounds based on cellulose which has been the mother of many great chemical developments such as nitrocellulose for protective coatings, plastics, coated textiles and photographic film; cellulose acetate for plastics, photographic film and textiles; rayon by several processes including viscose, cuprammonium; and ethyl cellulose for plastics and protective coatings. This newest product enters fields which previously have not been touched by the cellulose derivatives."

Welding Generator Set

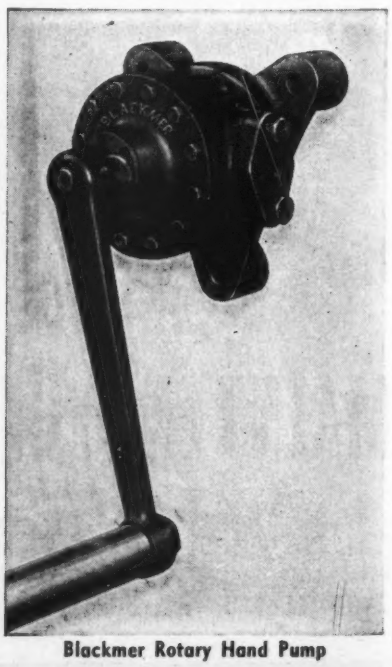
Century Electric Company, St. Louis 3, Missouri, has announced a motor generator set which will supply welding power for from 15 to 30 men, welding at the same time.

The motor is a 160 horsepower, 440 volt, 60 cycle, 3 phase, 1160 RPM, one hour 50° C temperature rise, squirrel cage induction type motor with drip-proof construction.

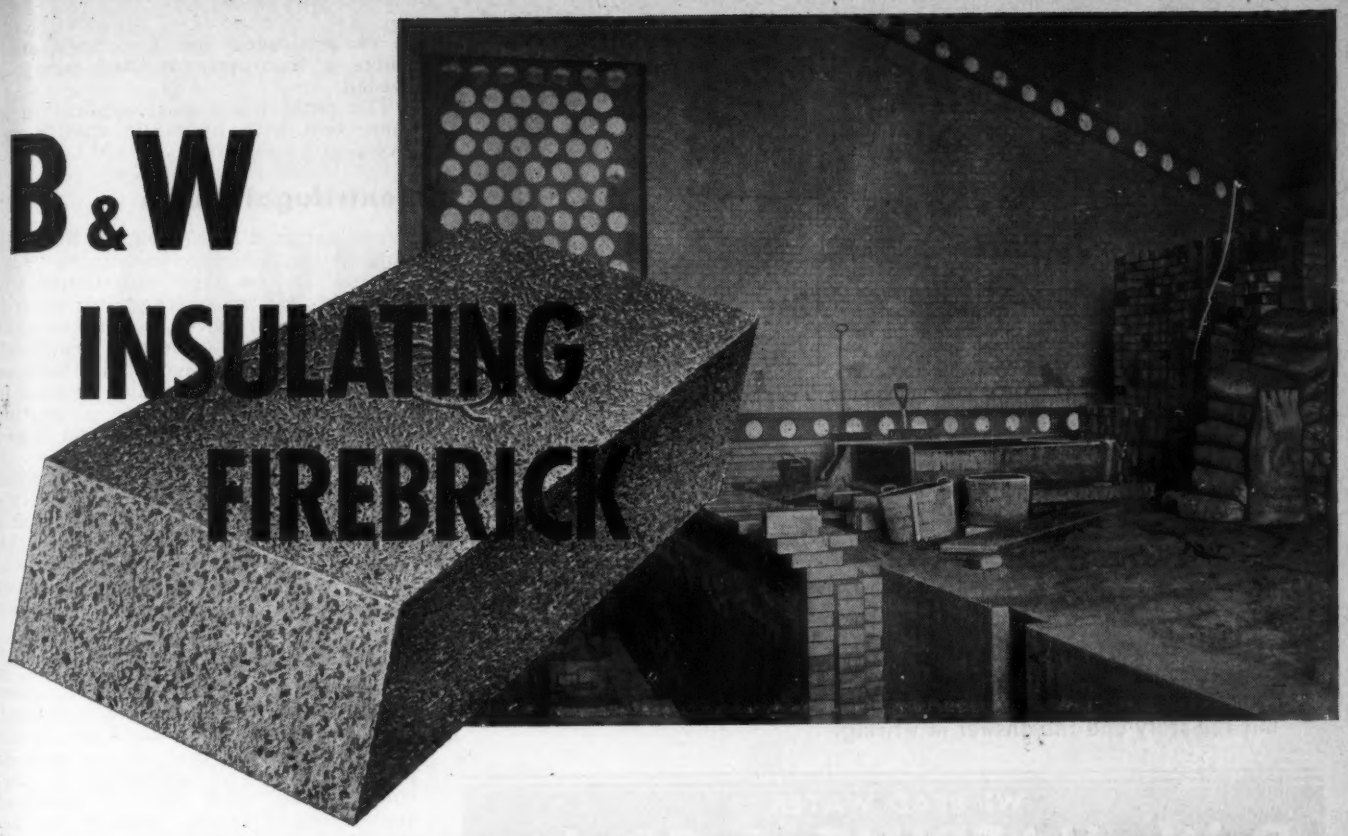
This motor drives a 70 volt, 1500 ampere, flat compounded, direct-current generator, rated one hour 50° temperature rise.

High-Pressure Hand Pump

Blackmer Pump Company, Grand Rapids 9, Michigan, announces an all-bronze rotary hand pump that develops a pressure of 125 pounds per square inch and has a capacity of 1.5 GPM, and



Blackmer Rotary Hand Pump



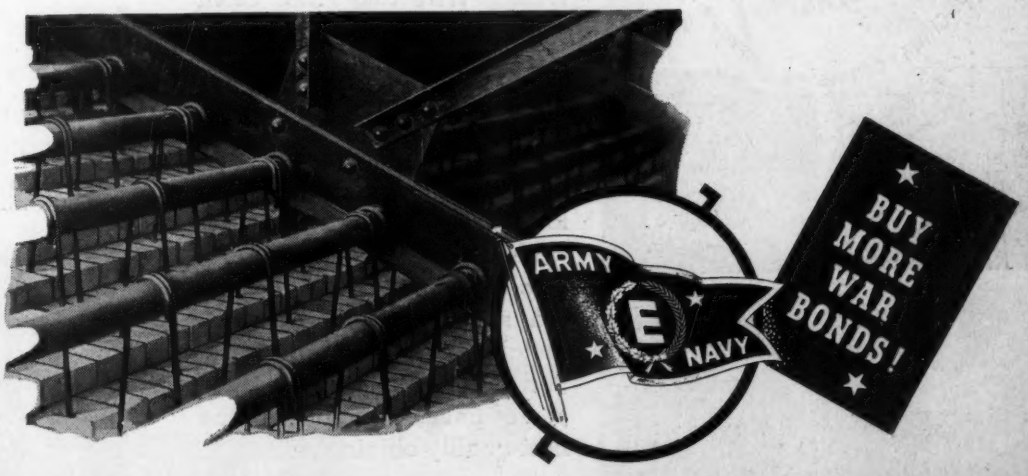
USED EXCLUSIVELY IN OIL HEATER AT SUN'S NEW 100-OCTANE REFINERY

Record production of aviation gasoline is expected at the Sun Oil Company's new Marcus Hook plant.

This oil heater (photographed during construction), designed by Alcorn Combustion Co. of Philadelphia, is lined throughout with B&W Insulating Firebrick. Selected for their conductivity and low heat capacity, these brick assure high thermal efficiency and continuous, dependable service in oil heaters.

B&W Insulating Firebrick are in daily use in a great many refineries throughout the country. The initial installation in oil heaters was made in 1932.

R-181

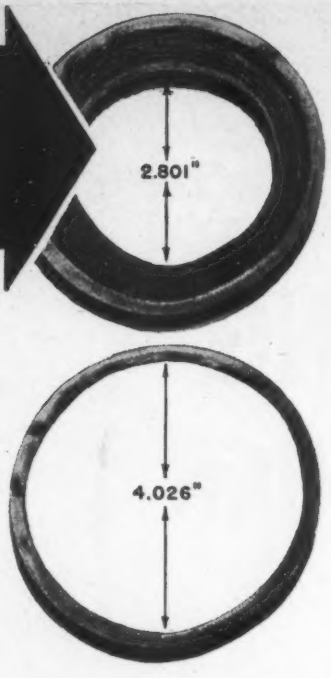


Roof detail, showing method of suspension

THE BABCOCK & WILCOX COMPANY • Refractories Division • 85 LIBERTY ST., NEW YORK 6, N.Y.

BABCOCK & WILCOX

Pipe clogged by scale to HALF its efficiency



HAERING GLUCOSATES

REMOVE THIS SCALE AND MAINTAIN FULL CAPACITY FLOW . . .

Scaled pipes cost money.

Scale prevention pays dividends.

We will send you any of our technical publications. Better yet, a Haering Field Engineer will survey your plant and submit the story and the answer in writing.

WE READ WATER

D. W. HAERING & CO., Inc.

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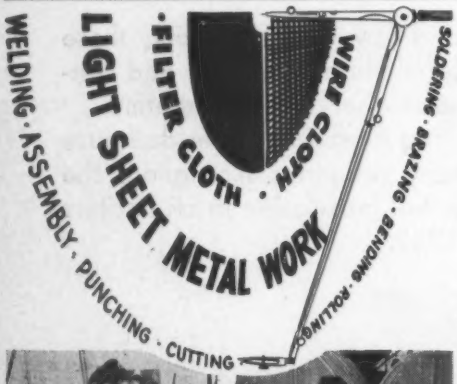

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● If you want trouble-free, long-lasting Wire and Filter Cloth assemblies or sheet metal fabrication, submit your problem to us. Most likely we can solve it as we have solved hundreds of seemingly unsolvable problems for our clients during the last 32 years.

Materials of the highest quality combined with skilled workmanship have given Multi-Metal products their proud position of leadership and assures you of finished products of the best quality obtainable.

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ALL MESHES
ALL METALS

is recommended for any application where a high-pressure hand pump is needed.

The outfit has special application in connection with hydraulic control devices.

Centrifugal Clutch

Amalgamated Engineering & Research Corporation, Chicago, announces "Torkontrol," a new type of automatically engaging and self-disengaging centrifugal clutch. Produced in an unlimited range of sizes and capacities, this clutch can serve either as a coupling between shafts or as a driving pulley or gear in a transmission, as well as a starting cushion between power units and driven mechanism.

The unit consists of a partially filled oil chamber fitted with a freely rotating hub which carries a series of movable wedge shaped fly-weights. As the hub revolves these weights fly outwardly and engage the internal rims of the outer case, binding the hub and shell into a functionally solid pulley or coupling.

Since the unit works equally well in either direction, it is reversible, and is set to engage or release at a given speed, and to slip in case of over-load.

Features of the unit, according to the manufacturer, are that its use permits smaller engines or motors which start without load, gives smooth cushioned application of power, straight-line acceleration, with resulting reduction in operating cost. Because the clutch combines features of both lubricated and centrifugal clutches, because it can be made in all sizes and can be operated horizontally or vertically, is set to engage and release at any predetermined speed, it has applications wherever power is transmitted through shafts, as a complete or integral unit.

These clutches have been built in sizes ranging from ¼ to 500 horsepower.

Shimble

Garlinghouse Brothers, 2416 East 16th Street, Los Angeles 21, California, announce a regular pattern Shimble, for general application.

The regular pattern "Standard" is the equivalent of a standard shackle, and the regular pattern "Style A" is the equivalent of a regular socket. Available in a full range of rope sizes from 1/8-inch to 1-5/7-inch, the shimble provides for the safe strength of rope. These shimbles are hot forged from mild steel bars to provide rigid support for wire rope in non-collapsible contour, which is said to be the most

Gar-Bro Shimble

8 reasons why CARBON and GRAPHITE are ideal materials for industrial applications

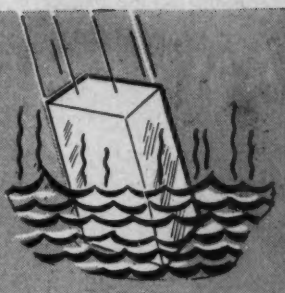
THE Carbon and Graphite and "Karbate" materials manufactured by National Carbon Company possess chemical and physical properties ideally suited for many applications in the chemical and process, petroleum, metallurgical, textile, electrical and mechanical industries. A choice of grades, with or without several processing treatments, will meet specific conditions requiring a *combination* of properties found exclusively in these materials.

A few of these properties are illustrated on this page. A careful study of these will reveal applications assuring trouble-free operation and low maintenance cost. National Carbon Company engineers will be glad to consult with you on your problems.

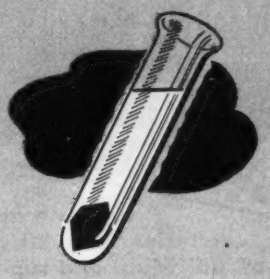
The word "Karbate" is a trade-mark of National Carbon Company, Inc.

★ BUY UNITED STATES WAR BONDS ★

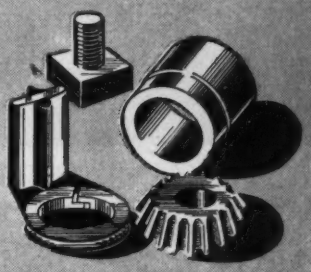
1. Corrosion resistance. Carbon and graphite are inert to all but highly oxidizing conditions, and to most acids, alkalies and solvents.



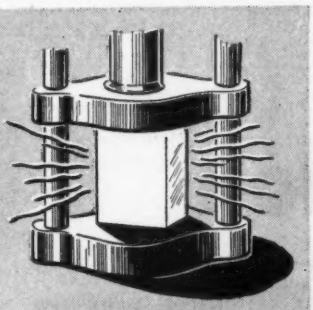
2. Resistance to thermal shock. Carbon and graphite do not spall or crack even under sudden and extreme changes of temperature.



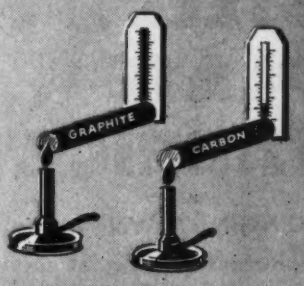
3. Absence of contamination. Carbon and graphite are insoluble and are not picked up in caustic and spin bath solutions.



4. Ease of fabrication. Carbon and graphite are readily machinable to intricate shapes and close dimensional tolerances.

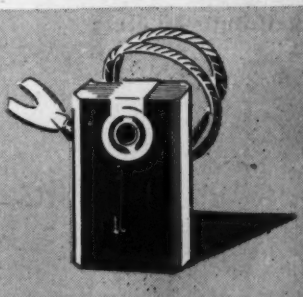


5. No deformation at high temperatures. Carbon and graphite retain their shape in extremely high temperatures.



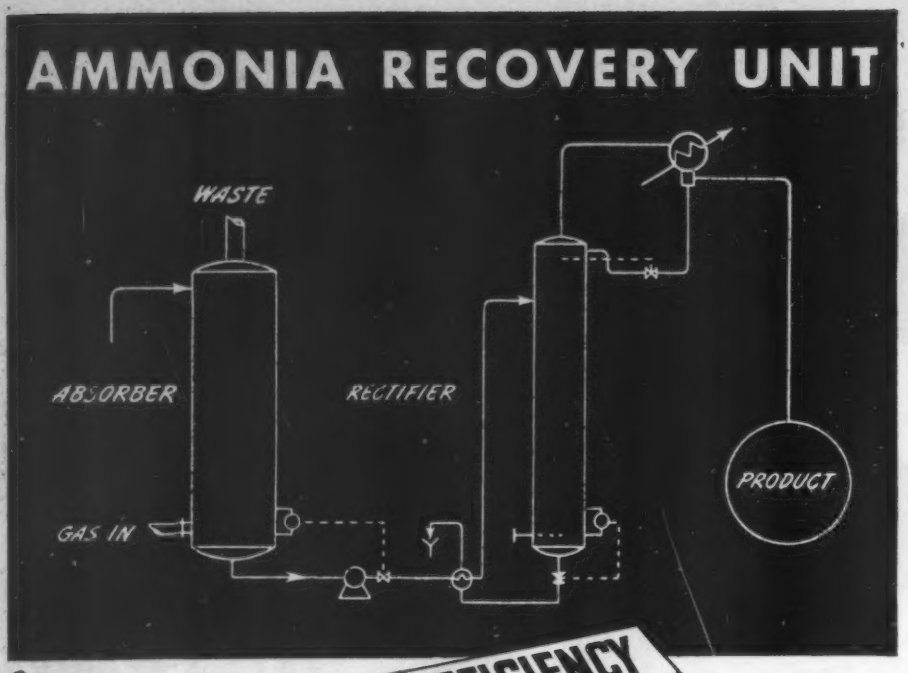
6. High or low heat transfer. Graphite has *high* heat transfer properties; carbon has *low* heat transfer properties.

7. Not wet by molten metal. With carbon and graphite, molten metals flow freely without slagging or sticking.



8. Electrical conductivity. Carbon and graphite have various degrees of conductivity for a very broad range of electrical conditions.

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
Carbon Products Division, Cleveland, Ohio
General Offices
30 East 42nd Street, New York 17, N. Y.
Branch Sales Offices
New York, Pittsburgh, Chicago, San Francisco



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Have an ammonia recovery unit especially designed. You get the benefit of individual and superior engineering by consulting S. D. Hicks & Son Company, Inc. You will get the answer promptly. *Write us for our bulletin.*

S. D. Hicks & Son Co., INC.

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DOWNINGTOWN is equipped to design, layout, and manufacture almost anything in unfired pressure vessels to meet the approval of A.P.I. and A.S.M.E.

Fractionating columns, Bubble Towers, Knockout Drums, Distillate Receivers, Bulk Storage Tanks. Air Receivers, Acid Storage Tanks, Stills, Waste Heat Boilers, Heat Exchangers, etc.

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efficient rope fitting for direct-pull applications, and to give improved rope protection.

An element of design said to be of especial value is that the small area of rope-to-shimble contact insures quick drainage and drying which largely eliminates corrosive action by salty moisture.

Standard Methods for Testing Petroleum and Its Products

Fifth Edition, 1944.

Published by The Institute of Petroleum, London, England.

500 pages, 127 diagrams. 15s. Od. ($3.00).

This new edition of The Institute of Petroleum's handbook contains details of ninety-seven methods for testing petroleum and its products.

New matter includes an additional method for determining aniline points of volatile materials, a low temperature filtration test for gasoil and diesel fuels, the Fraass breaking point test for bitumen, a congealing point test for waxes for which the setting point method is unsuitable, a method for determining the water tolerance of a motor fuel, new distillation tests for crude oil and residues, a method for estimating the salt content of crude oil, and the use of the Abel Flash Point apparatus for viscous petroleum mixtures and of the N.G.A.A. metal pyknometer for determining the specific gravity of liquefied gases. A.S.T.M Methods, with slight modification, have been adopted for determining the T.E.L. content of motor fuel and the residue on evaporation of kerosine and tractor fuels.

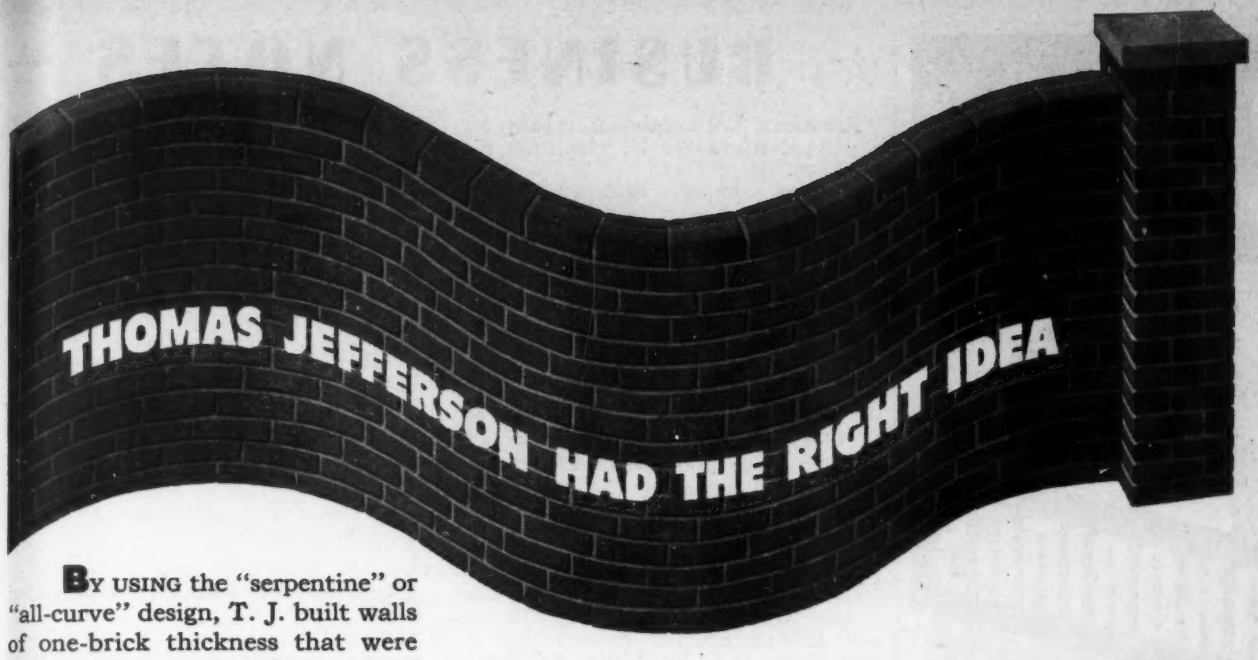
An innovation in this edition is the inclusion of a series of methods for testing bituminous emulsions and chemicals, such as ethers, ketones, drying oils and wetting agents, derived from petroleum.

The sampling methods have been completely revised, and major alterations have been made in the following methods: Acidity, Ash Content, Ramsbottom Carbon Residue, Cold Test of Motor Fuels, Colour (Lovibond), Dielectric Strength, Doctor Test, Drop Point, Free Acid and Alkali in Grease, Knock Rating, Oxidation of Lubricating Oils, Oxidation (Gum) Stability of Motor Fuels, Penetration, Sludging Value, Softening Point, Reid Vapour Pressure, and Kinematic Viscosity.

Specifications for wartime hydrometers and thermometers are included, and the "Appendix" has been enlarged by the addition of a standard scheme for evaluating crude oils and a vapour pressure / temperature nomograph for hydrocarbons.

The book can be obtained in the United States from The American Society for Testing Materials, 260 So. Broad Street, Philadelphia, Pa.

Nelson E. Chance, industrial manager of the New office of The Brown Instrument Company, died March 12 at Summit, New Jersey. He had been with the company 22 years, having spent his earlier days with the organization in the Southwest, working out of Dallas. He was a graduate of Bucknell University and for many years had been a member of the Society for Measurement and Control.



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The same principle is used in Badger Packless Corrugated Expansion Joints. Badger ALL-CURVE corrugations, together with Badger ALL-CURVE Equalizing Rings, distribute and absorb *evenly* the normal stresses caused by pipe expansion and contraction. There is no tendency of stresses to converge or localize, as is the case with corrugations having straight sides, angles or "junctions." Badger Joints have the further advantage of

DIRECTED FLEXING

—with the Equalizing Rings doing the "directing." These rings preserve the strong ALL-CURVE contour of the corrugations—keep them from "flattening out"; hold movement within prescribed limits; form an added bulwark against excessive stresses. What these things mean in higher resistance, greater dependability, longer joint life, is clear to any engineer.

PACKLESS, too! A single piece of tubing comprises the corrugated member. No packing—hence no packing maintenance—is required. Manhole and tunneling expense is saved in underground installations.

COMPACT, as well! No space is wasted . . . Badger Joints take up no more room than a comparable flanged fitting. You can't find better expansion joints anywhere!

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come in Copper for normal pressures and temperatures; in Stainless Steel for higher pressures and temperatures—and where corrosion is a problem. Single and multiple corrugations—to take care of traverses ranging from a fraction of an inch upward.

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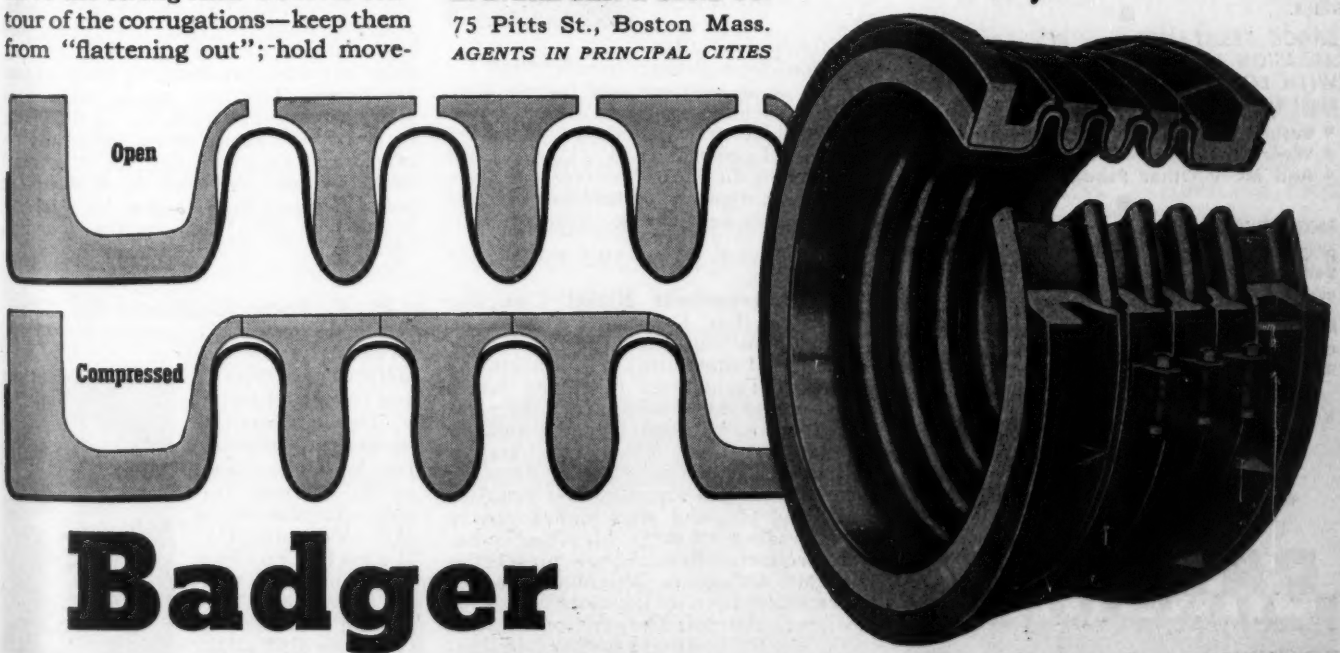

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☆ BUSINESS NOTES ☆

American Locomotive Company has appointed Alexander M. Hamilton vice president in charge of foreign sales. Between World War I and World War II Hamilton held various foreign sales positions with the company, serving as European representative with headquarters in Paris after the Armistice until 1921. He is presently executive vice president of Montreal Locomotive Works, Ltd., Canadian subsidiary of American Locomotive Company. He first saw foreign service in 1915 when he went to Russia as the company's representative to supervise the erection of locomotives sold to that country. Subsequently he was in charge of locomotive erection in various foreign ports throughout the world. He served in the U. S. Field Artillery during World War I. A graduate of Cornell in 1909 with the degree of Mechanical Engineer, he is a member of the Export Managers Club, and was president of the club from 1931 to 1933. He toured South America in 1941 as a member of the National Research Council.

A. M. Hamilton

Elliott Company has announced appointment of Corliss A. Bercaw as assistant general manager of its Springfield, Ohio, Division. Bercaw, former Baldwin Locomotive and Westinghouse executive, received his degree in mechanical engineering at California Institute of Technology. A naval ensign and aviator in World War I, he joined Westinghouse after his discharge from service, as an engineer, and became special representative of the diesel engine division. He was associated with the Baldwin Locomotive Works as sales manager of diesel locomotives and later production manager of the diesel engine division before joining Elliott Company.

C. A. Bercaw

The International Nickel Company announces that Dr. V. N. Krivobok, authority on stainless steel and former professor of metallurgy at Carnegie Institute of Technology for many years, has become associated with the Development and Research Division of the company at New York. His services will be utilized mainly in the development of markets for alloy and stainless steels and to assist steel manufacturers in expanding markets for their postwar products. Residing at present in Glendale, California, Krivobok had until recently been chief metallurgist of Lockheed Aircraft Corporation at Burbank. Before joining Lockheed in January, 1941, he had been professor of metallurgy at Carnegie Institute of Technology since 1924 while also serving as associate director of research for Allegheny Ludlum Steel Corporation (1934-1940). From 1924 to 1934 he had been consulting metallurgist to several steel companies. A graduate of Harvard Engineering School, Krivobok's many papers on stainless steels and other steel alloys have been widely published. One of his best known papers, "Alloys of Iron and Chromium," he presented in October, 1934, as the ninth Edward de Mille Campbell memorial lecturer for the American Society for Metals. He is a member of the American Society for Metals, British Institute of Metals, American Institute of Mining & Metallurgical Engineers, American Society for Testing Materials and the Russian Metallurgy Society.

The National Radiator Company, Johnstown, Pennsylvania, has announced appointment of Paul B. Holmes, as manager of sales of the Heating Division. He succeeds the late Charles L. Crouse. Holmes has been with the company 27 years, first in the office of the Washington branch, later a salesman in this territory, and being promoted to branch manager in 1935.

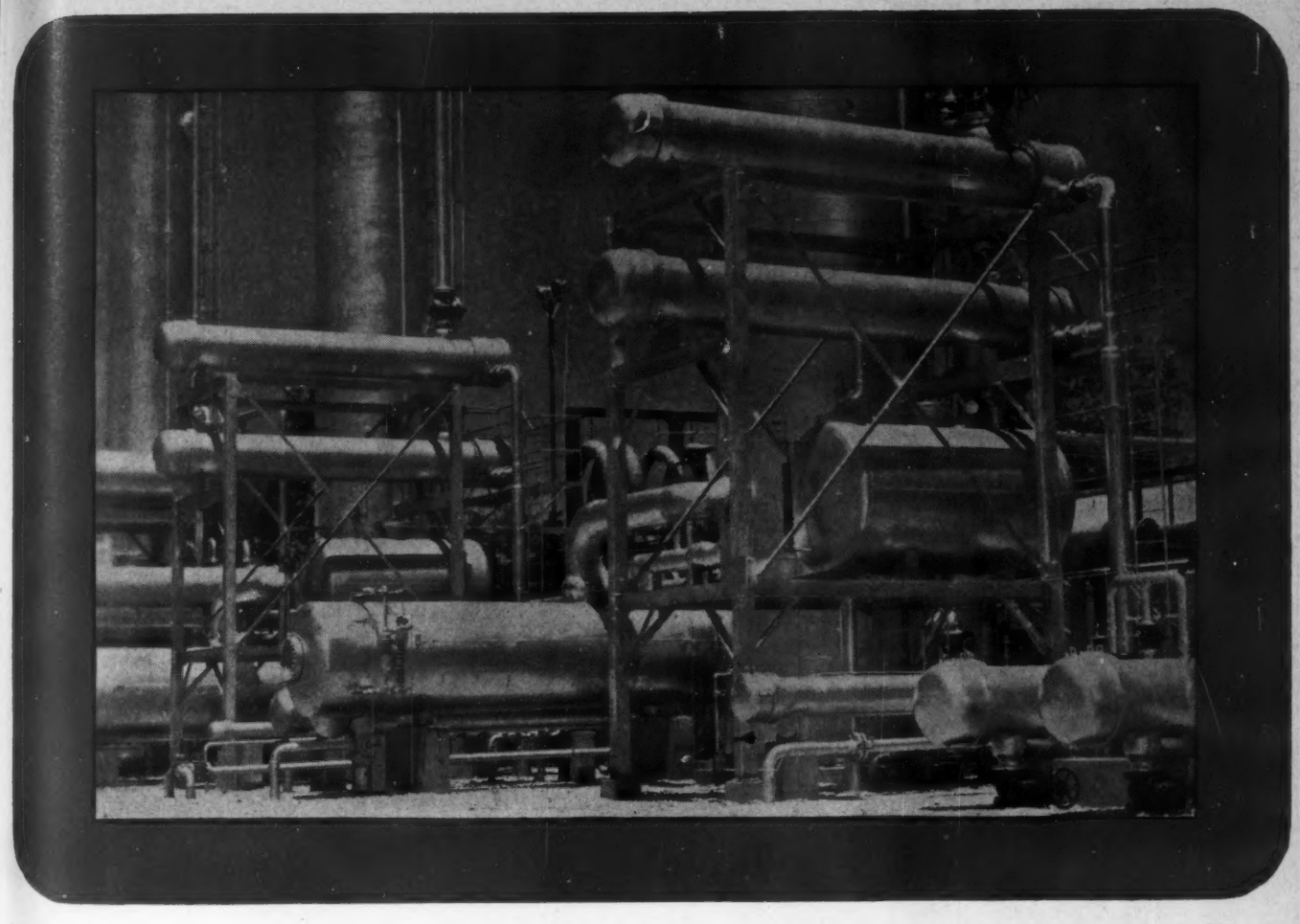
P. B. Holmes

During 1939-1941, he supervised the operation of the Washington and Richmond offices. Special assignments in Washington in connection with war orders and priorities, made it necessary for him to relinquish supervision of the Richmond office, and he became the liaison representative between the company and government agencies.

Harnischfeger Corporation, Milwaukee, Wisconsin, has established a separate division for handling repair and replacements of P&H products as a result of war production burdens on equipment. The new repair asles division is being managed by J. D. Glatz, recently returned from Washington after two years with the WPB as chief of the crane and hoist section in the tools division. Prior to that he was representative for P&H in the Chicago area.

H. K. Porter Company, Inc., Pittsburgh, Pennsylvania, has purchased Mt. Vernon Car Manufacturing Company and its subsidiary, J. P. Devine Manufacturing Company, Inc., both with plants at Mt. Vernon, Illinois. Acquisition of Mt. Vernon Car Manufacturing Company, representing approximately 10 percent of the nation's freight car manufacturing capacity, makes Porter

T. M. Evans



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The first ELECTRUNITE Pressure Tubes were installed in 1932—and immediately began to establish records. Today, more than 120,000,000 feet have been installed in all types of steam generating and heat transfer equipment, in every kind of service.

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the largest in this industry, with assets in excess of $10,000,000. An active expansion program is planned; the Process Equipment Division will cooperate in development of tank cars for better transportation of chemical products.

J. P. Devine Manufacturing Company's facilities for making heavy chemicals, food, and oil refinery equipment will make the Porter Process Equipment Division the largest manufacturer in the process field, with a complete line ranging from the smallest agitator to the largest fractionating column.

This is the company's fourth entry into new fields since T. M. Evans became president in 1938. It has added its Process Equipment Division to the original locomotive plant; built and is operating a naval ordnance plant at Blairsville, Pennsylvania; and in 1943 purchased Quinby Pump Company, with plants at Newark and New Brunswick, New Jersey.

Westinghouse Electric and Manufacturing Company has appointed William D. Turnbull manager of its agency and specialties department. This marks his return to the company after an absence of four years. He first joined the Westinghouse staff in 1923, after graduation from Pennsylvania State College. He was manager of the Westinghouse Machinery Electrification Section before becoming associated with Pomona Pump Company as vice president and sales manager.

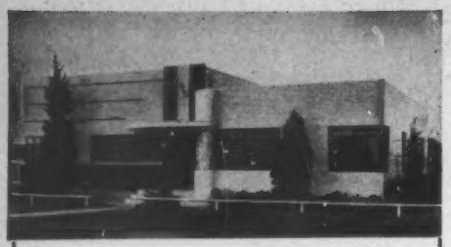
Young Radiator Company, Racine, Wisconsin, has announced that R. P. Exten will come to it as executive assistant to the president, Fred M. Young. Exten received his early training in the automotive and accessories fields serving in various capacities with Studebaker Corporation, Timken-Detroit Axle Company and the Hudson Motor Car Company. He was more recently associated with the Climax Engineering Company, Clinton, Iowa, as chief draftsman and assistant engineer, and the Mechanics Universal Joint and Rockford Drilling Machine Divisions of the Borg-Warner Corporation, Rockford, Illinois, as production engineer. One of his recent accomplishments was the invention and design of the first successful, lightweight, high torque capacity clutch for engaging the horizontal rotor of the autogyro.

Edward V. Creagh has been appointed advertising and sales promotion manager of American Chain & Cable Company, and associate companies. He joined the company in 1916, and has been in charge of sales promotion since 1936. One of the organizers and first president of the Western New England Chapter of National Industrial Advertisers Association, Creagh is now serving as a vice president of the national organization.

Cochrane Corporation, Philadelphia, announces acquisition of exclusive sales rights to the line of Rotameters manufactured and hitherto sold by Rotameters, Inc., of Jenkintown, Pennsylvania. According to P. S. Lyon, president of Cochrane Corporation, this is a logical addition to his company's meter line, as it has manufactured and sold a recording area type meter for the past seven years and the addition of the

A view of one of many plants designed and constructed by Petroleum Engineering, Inc., in the past 15 years of continuous service to the industry. Petroleum Engineering, Inc., Offices: Tulsa and Houston.

Photographed for Petroleum Engineering, Inc.
By Robert Yarnall Richie



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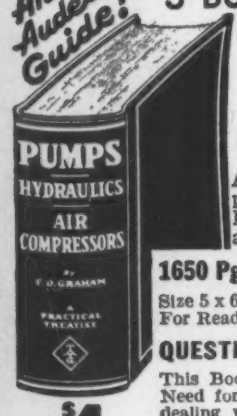

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rotameter, or indicating type of area meter, rounds out the line. No change will be made in the personnel of the two companies, William C. Bennett being manager of Cochrane's appliance division, with W. W. Tomes in charge of sales and William Melas in charge of engineering, while for Rotameters, Inc., J. B. Vandegrift, recently appointed general manager, is associated with Alfred Elsasser, technical director, Robert C. Wolf, chief engineer, Reynold Wilson and Joseph Madden, glass technologists, and Howard Forepaugh, office manager, several of whom helped pioneer the development of the American rotameter into a successful measuring device with interchangeable precision-bore tubes. The Rotameter will be sold by Cochrane flow meter representatives.

The Hooker Electrochemical Company, Niagara Falls, New York, has appointed John S. Coey to its sales development department. He is a graduate in chemistry from Amherst College. For the past seven years he has been in the manufacturing department of the company, in charge of the process study group engaged in the improvement of processes, operating efficiencies, and quality of products.

The C. M. Kemp Manufacturing Company, 405 East Oliver Street, Baltimore, has appointed Robert Arnold Sales & Engineering Company, Otis building, Philadelphia 2, to represent it in the Philadelphia area.

The Marley Company announces personnel shifts resulting from raising its Houston office to the status of divisional headquarters under the direction of Ray T. Jenkins, who formerly handled the Tulsa Division.

The company is now represented in the Tulsa area (all of Oklahoma, Western Arkansas and Texas Panhandle) by Process Equipment Company, 306 Tulsa Building.

Joe T. McKinley of the main office has joined the Houston staff. The Kansas and Western Missouri area is now handled by R. H. Ahrens out of the company's headquarters at Fairfax and Marley Roads, Kansas City, Kansas.

The National Tube Company has elected R. Heath Larry secretary to succeed the late E. W. Criswell. His offices are at Pittsburgh. Major Southwest headquarters of National Tube Company are located at Dallas, Houston and Tulsa.

Ansul Chemical Company, Marinette, Wisconsin, has named Philip J. Ehman, for the past eight years a research chemist, as assistant research director under Dr. Walter O. Walker. Ehman, born and reared in Montana, received his B.S. in 1932 from Montana State College and his Ph.D. from the University of Chicago.

The Carborundum Company, Niagara Falls, New York, has appointed Charles W. Sprenger as district manager for the metropolitan New York district, with headquarters at the New York warehouse and sales office, 601 West 26th Street. He assumes his new duties after long experience in the abrasive field.

Announcement was also made of the appointment of Joseph C. Steele as district office sales manager at New York. He succeeds E. W. Martin, who has been named as regional sales office manager of the Eastern sales districts.

Pittsburgh Equitable Meter Company recently named W. F. Rockwell, president of the company since 1926, chairman of the board of directors and he will continue active head of the company in the dual capacity. E. W. Meyers, treasurer for the past 18 years, was named a vice president and will continue as treasurer, and W. S. Potter was advanced from assistant works manager to vice president.

Maxim Silencer Company has announced appointment of Roland B. Bourne as vice president in charge of research, and Frank L. Orr as vice president in charge of sales. Bourne has been director of the company's research department since 1925 and previously had engineering positions with C. D. Tuska Company, radio equipment manufacturer, and with Radio Corporation of America. He is a graduate of Rensselaer

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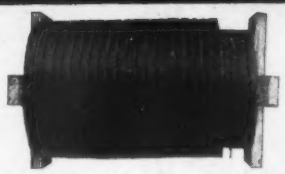

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5. Slowly remove scale and corrosion now in system.
6. Adaptable to filtration or "sludge" settling.
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Polytechnic Institute. Orr joined the company in 1930 as district manager of the New York office, and became sales manager when the sales department was moved to headquarters at Hartford, Connecticut, in 1936. Another recent appointment of the company is that of O. S. Johannsen as manager of the New York office. A native of Norway, Johannsen is an engineer with several years experience previous to 1917 when he became sales representative for a number of manufacturers of diesel engines and marine engineering specialties.

Cardox Corporation announces the advancement of J. Paul Oliver to administrative technical assistant of the research division. He has been for two years superintendent of the Cardox electrochemical plant at Claremore, Oklahoma. This position will be filled by Dr. Lawrence M. Liggett. Dr. Liggett received his doctor's degree from Iowa State College where he was formerly an assistant instructor of analytical chemistry.

Dr. James A. Taylor has joined the research division as chemical engineer. He is a graduate of the University of Iowa and received his doctor's degree from the University of Washington in 1932. From 1934 to 1942 he was assistant professor of fuel technology at Pennsylvania State College.

Landis Machine Company, Waynesboro, Pennsylvania, has appointed John H. Elliott general manager. He has been secretary of the company the past four years and will continue those duties.

C. J. Tagliabue Manufacturing Company has announced recent election of A. F. Rucks as president and general manager, to succeed the late C. D. Waters. Rucks has held several important positions with the company during the past 30 years.

Jones & Laughlin Supply Company has been organized to succeed Frick-Reid Supply Corporation, a wholly owned Jones & Laughlin Steel Corporation subsidiary. The change in name was made to more clearly identify the supply company's activities and its relationship to the corporation, it was explained. The principal office of the new company will be at Tulsa.

For 40 years Frick-Reid Supply Corporation has served oil and gas industries and in recent years its activities have been enlarged to include process engineering and construction of refineries, gasoline plants, recycling, repressuring and other types of plants.

J. L. Shakely, who has been with Frick-Reid more than 30 years, and president since 1938, has been elected president of the new company. Other officers, including Robert McCoy, Jr., executive vice president; H. H. Wilson, vice president, and P. R. Warner, treasurer, also have been elected to serve in identical capacities with the new company.

Reappointments in the new company organization include R. P. Mase, chief engineer; N. C. Turner, assistant chief engineer; S. A. Whitehurst, manager of sales; V. C. Canter, general superintendent; L. G. Sutter, assistant general superintendent, all of the engineering and construction division, and Rainey Elliott, sales manager of general supplies.

The Foxboro Company, Foxboro, Massachusetts, has named Charles Schwarzler as manager of the export department, succeeding Henry B. Moelter, deceased. Schwarzler was formerly manager of the sales promotion department.

Dr. Warren W. Leigh has resigned as special assistant to the Deputy Rubber Director of WPB to join Ralph C. Busbey in organizing Busbey & Leigh, management consultants, 316 Water Street, Akron, Ohio. Leigh served with WPB for more than a year, previously serving as price consultant and head of the tire price section of OPA. Before serving the government, he was head of the commerce department and professor of business administration of the University of Akron. Busbey is head of the Busbey Advertising Agency of Akron. Busbey & Leigh will deal extensively with postwar planning for special clients, its services also embracing research, advertising, marketing and business analysis.

WANTED: Poly Plant Operators—Light Ends Operators—Instrument Men—Metal Inspector—Pumpers: For new Aviation Gasoline Refinery consisting of Catalytic Cracking, Alkylation, and Isomerization units. Location, Middlewest. In reply give detailed outline of previous experience, education, draft status, and required earnings for 48-hour week. Address: Box 590, c/o Petroleum Refiner, Houston, Texas.

WANTED, construction superintendents and general foremen for general construction work. Must be familiar with all phases of construction in refineries and chemical plants. Should have some knowledge of operatons. Give complete information, age, education, experience, ability, salary, availability, draft status. Replies confidential. Address: Box 999, care Petroleum Refiner, Houston, Texas.

WANTED—INSTRUMENT MEN

For new Aviation Gasoline Refinery consisting of Catalytic Cracking, Alkylation, and Isomerization units. Location, middlewest. In reply give detailed outline of previous experience, education, draft status, and required earnings for 48-hour week. Address: Box 500, c/o Petroleum Refiner, Houston, Texas.

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"Chemical Engineers with experience in any of the following petroleum refining operations (1) light ends recovery equipment, absorbers, stabilizers, etc. (2) catalytic cracking equipment or (3) crude distillation equipment and similar processing units. State in detail educational background, positions held with detailed explanation of work handled, age, and number of dependents also draft status." Address: Foster Wheeler Corporation, Petroleum Refinery Division, 165 Broadway, New York 6, N. Y.

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